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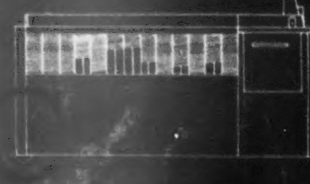
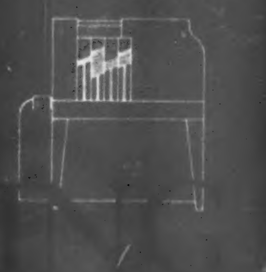
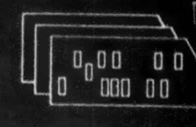
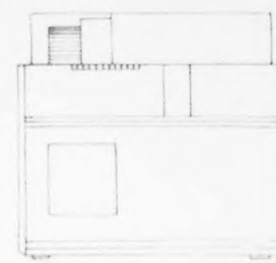






JOURNAL OF MANAGEMENT AND INFORMATION SYSTEMS



Survey of ADP Systems and Equipment

Good Times on Computers

Research Today

The Business Efficiency Exhibition —a Preview

AUTOMATIC DATA PROCESSING

VOL 2 No 9 CONTENTS SEPTEMBER 1960

JOURNAL OF MANAGEMENT AND INFORMATION SYSTEMS

AUTOMATIC DATA PROCESSING SYSTEMS AND EQUIPMENT UNDER SCRUTINY

The first instalment of a comprehensive survey of ADP equipment begins on page 29.

AUTOMATIC DATA PROCESSING

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Comment

The Gap

REMEMBER the old chest expanders? Five minutes twice a day for a month, and the muscles in your arms fair rippled, the chest strained at the shirt buttons. Fit, you thought—till you tried junior's bicycle and your legs turned to putty. Odd, but data processing's a bit like that just now. Beefy in one or two areas, but flaccid elsewhere.

Take computers. Plenty of brawn there. At least two or three companies have brought out machines that are *right*: they have, if you like, hit on the requisite 'capacity and speed to price ratio', and a flock of people have decided to instal. These machines—and some of their predecessors—are going to give a lot of use, and are not going to be 'obsolete' in three, five or seven years. Why not? Two reasons.

First, it is possible to start, for a figure somewhat below £70,000, an installation comprising the three basic units (card reader-punch, arithmetic unit, and fact printer) and to run at least two or three procedures. If the company expands or wishes to automate further procedures, it can buy extra core storage and some tape units, and the expanded installation can handle it. Alternatively, where the system cannot have new bits grafted onto it, there may be a case for ordering 'the same again'. By now it is recognised that it takes more than the purchase price of a computer to introduce automatic data processing into a firm; there are programmers to hire or train, programs to write, etc.—and a second machine of the same make could mean new procedures might be run more cheaply than if an entirely new system were adopted.

Secondly, whatever the boffins are up to—with thin magnetic film and the like—it will be some time before the manufacturers have better bargains to tempt the businessman.

So the computer side, you might say, is healthy. Similarly, the output side of the data processing sequence is robust: there are for example about half a dozen line printers available that can print 600 lines in a minute. It's adequate.

Where there are inadequacies—temporarily—is in the 'data preparation' area. When a punched card reader can run through 600 cards in a minute, some organisation—and equipment—is needed to produce cards. In a number of cases small cohorts of girls working keyboards punches will do the trick. But in many others it won't, and for a host of reasons—keyboard punches and verifiers are expensive, so are full-time operators; to punch cards or tape you need source documents and *these* are sometimes expensive or impossible to produce; and there are many others.

Of course, a few short cuts have previously been offered, such as cash registers that produce paper tape and the like, but at a price . . . so the problem remains, or better—*remained*.

Now, the manufacturers have recognised the gap, the researchers have done their homework and a number of solutions are being or about to be offered. These will include data transmission systems, small (and inexpensive) punches and hand printers and other equipment. The upshot is that a large number of companies, particularly retail firms, which could previously make little use of centralised data processing methods, can now seriously consider automation.

No more putty legs soon.

The column for fast access to random information

More Banks Choose

After probing and study

A year ago it was announced that Barclays Bank were to invest £125,000 in an Emidec 1100 computer, and last April Martins followed their lead by ordering a Pegasus machine. Now after probing and study, two more banks have made up their minds about future mechanisation. Lloyds are to put down £350,000 for a system comprising three Ramacs. The system will be based on Lloyds' monster Pall Mall branch. The three Ramac units will be able, it is anticipated, to handle up to 100,000 entries on customers' accounts allowing for up-to-date information to be made available to the bank's executives at any time. Each unit will be capable of dealing with all data processing for 20,000 accounts. Once established, the machines will have considerable spare capacity, and Lloyds expect to be able to link other branches to the Pall Mall installation. Lloyds have already ordered a Burroughs cheque sorter, and when magnetic reading of cheques will be started this must await a decision on which of three alternative typefaces the banks collectively agree to adopt for automatic cheque sorting —the sorter will be linked up with the Pall Mall installation.

Hard on the heels of Lloyds the National Provincial Bank have announced they have ordered, for £200,000, an Orion computing system which will be put to work on 150,000 current accounts in a centralised London office.

Bull's Code

A demonstration to nudge

Perhaps to nudge the electronics subcommittee of the London Clearing Banks (which is to pronounce on which of the three magnetic character reading systems the banks will employ) De La Rue Bull recently arranged a demonstration in Paris of their CMB Magnetic Code. The demonstration was in two parts: first at the Societe Hermieu, one of the leading French firms of cheque printers, and later at the headquarters of the Credit Lyonnais Bank.

At the Société Hermieu, after an account of the CMB code and the different methods of printing required for cheques, the 32 representatives of British cheque printers and cheque papermakers saw a demonstration of cheque printing, letterpress, offset litho and numbering box-techniques using magnetic ink. At the Credit Lyonnais the imprinting of amounts in CMB magnetic characters on cheque with a desk imprinter, and cheque sorting were shown.

In addition to having very wide printing tolerances for magnetic characters—a very great asset to the printer—the CMB code has the advantage that it is available for alphabetical as well as numerical characters, and can be used on any type of data processing equipment.

Bottleneck eliminated

Stock Exchange improvements

As was reported in these columns recently the Stock Exchange has taken delivery of some card equipment and is moving towards mechanisation. The first major step was taken recently when the installation was put to work in the settlements departments on the sorting and listing of bargains.

In a way it is possible to sympathise with the Stock Exchange which has to depend for the provision of its source data on the co-operation of 500 independent units, brokers and jobbers, over which it has no mandatory control. Certainly, some mechanisation was needed in an operation that involves permanent staff—with the aid of regular casuals —working round the clock for perhaps two to three consecutive days in order to clear the bottleneck at the end of the account period.

First thought that the jobbers would be able to provide the source data for this work, it was then discovered that the error factor (a sample taken revealed it amounted to 18 percent) was present in the jobbers' books, but not in the brokers' records. Thus the brokers' daily list of bargains made has become the source data, giving the five factors that must be accounted for, the name and number of first party (the broker), the second party (the jobber), the stock involved, the number of shares involved at the price.

The equipment consists of mark sensing reproducers, multipliers, sorters, collators and tabulators, a total of 18 machines with a capital value of £90,000. The Exchange are renting this equipment for £1,500 per month from ICT. The operation comprises providing daily lists of bargains made for both the broker and the jobber, and also lists of takers and deliverers for the end of the account operation. Only the 160 of the most frequently dealt-in stocks will be handled with the new system, though it is hoped that the other stocks will be brought in, as circumstances permit. However, the present system will be able to facilitate the clearing of 150,000 bargains in these accounts—as opposed to 60,000, the maximum possible under the manual system. It will also do away with the bottlenecks and overtime working of the Stock Exchange staff, and will allow for a substantial reduction in the current labour force working overtime—of 150 whole and part-time workers.

A permanent expert committee of

DATA DIGEST

Under review—an extension of the present setup

the Stock Exchange is considering new extension of mechanisation for the near and also the dim and distant future, when brokers and jobbers firms will be reduced to the Partners and secretaries, with the machines doing the rest of the work.

Move to Europe

Looking for outlets

Another large American company, seeking an outlet in Europe has formed an international consortium with established French firms. This is Thompson Ramo Wooldridge, dealing with industrial engineering. The two French firms involved are the big CSF and the Intertechnique Co. The company thus formed by the consortium is the Compagnie Européenne d'Automatisme Electronique, whose object will be to build and sell digital computers for industrial control applications. It is thought that the RW 300 Digital Control Computer made by Thompson Ramo Wooldridge may be the computer which will be manufactured. The new company's headquarters will be in Paris, in the Rue Lavoisier, and their target will be all the countries of the Common Market.

Basic English

New language for writing programmes

At a one-day symposium on data processing for insurance recently Ferranti anounced that they had devised a new automatic programming language, called NEBULA, which, they claimed, was simpler and more flexible than existing autocodes, with a greater potential for extension.

Nebula is akin to Pitman shorthand in that it is based not so much on words as on phrases, which are readily understood, plus punctuation marks and other familiar signs. This makes it ideally suited for business users who may be unfamiliar with conventional programming methods, while for experienced programmers it may be rendered in the customary abbreviated symbolic form—a sequence of letters, numerals, and other symbols, etc.

Instructions in the Nebula language, either in the abbreviated or familiar form, would be typed out directly on to a keyboard by an operator, and so transferred to cards or tape. Fed into the computer it is automatically translated into machine language which the machine will recognise.

In addition to the basic restricted word list, the computer user can build up his own list of words, provision being made on the computer for the words to be translated and recognised. In this way the use of a foreign language such as French or German is possible as a basis for Nebula.

Drum for outer space

Storage for 100,000 bits

A miniature drum weighing only six ounces, but with the capacity to withstand fifteen times the force of gravity, has been developed by IBM for their airborne computers.

The drum, three inches long and three inches in diameter, spins at six thousand r.p.m., and is able to record as much as a hundred thousand bits of information on its magnetic surface. Made of stainless steel, it is a thin steel construction which is able, by concentrating the drum's mass at the surface where it is most needed, to withstand the shock of gravity, and also the high-frequency vibrations found in missiles.

75 Documents a minute

NCR High Speed printer at C & B

Crosse and Blackwell, the food manufacturers, are now using a National line printer, capable of high-speed printing, in their 405 installation.

It has been used to print out a complete revised visible record system of all the company's customers. This customer record, including customer's name and address, telephone number, account category, geographical dispatch centre and special delivery instructions, was printed out at a rate of 75 dockets per minute.

At C & B

The invoicing mill

The printer can be used either direct coupled to a computer or off-line, using either magnetic film or magnetic tape. In the case of the invoicing operation at Crosse and Blackwell, the invoices are prepared on the computer which magnetically records the information on to output films, which are then transferred to the printer and read electronically, sending out signals to the printing head to operate the printing mechanism.

Track computer

Random access to athletes

In co-operation with the Italian news agency, ANSA, IBM (Italy) set up an electronic information centre at their Rome office, and this centre

produced constantly summary sheets of the last ten events in the Olympic Games in three languages. Also it answered questions put to it by Press and public, also in the three official languages — Italian, French and English — on any information in its memory store.

In the store was background data on all athletes competing, results of previous Olympics, and Olympic, world and national records.

A special network fed the results of events into the computer as they occurred and the machine updated its memorised information and determined individual and team classifications. In its spare time the Ramac also processed a medical research project for the Italian Olympic Medical Committee on correlating the medical characteristics of athletes with their performance.

Jo'burg bound

Appointment in the Union

Since Leo Computers set up their Computer Service Bureau in Johannesburg a couple of months back, there has been some speculation as to which of the Hartree House executives would be seconded to control the South African set-up. Leo Fantl, one of Leo's pioneers in planning and programming and formerly Programming Manager in London, has been chosen.

Leo Fantl
programmed for PAYE

Leo Fantl has a considerable record behind him. He led the team which programmed the Ford payroll, and has been responsible for much government work, for the Ministry of Pensions and the Services, where he dealt with salary calculations, and—in a slightly more sinister vein—he programmed PAYE tax tables for the Inland Revenue. Other projects of his have included credit advice calculations for Glyn Mills Bank. His first major job in South Africa will be the planning and programming of the payroll of the many thousand mineworkers in the goldfields of Witwatersrand and the Orange Free State.

A realist with a quietly pungent sense of humour, Mr. Fantl served with the Czech squadron of the RAF during the war, joined the Lyons organisation and methods department on demobilisation and moved to Leo Computers soon after the subsidiary was established.

Points plotted

De Havilland offer processing service

A service designed primarily for industrial and scientific firms, but which might be extended to the whole commercial field, has been set up by de Havilland Propellers at their Stevenage works. Equipped with two complete systems of Benson Lehner Oscar Trace Readers lined to model F trace plotters, Mervyn Frequency Analysers with associated tape recorders, together with such ancillary equipment as Hollerith card punches, and card-editing equipment Creed tape-punches and IBM typewriters, they are prepared to undertake the processing of scientific data.

They will take in sets of graphs or pen-records — "graphic data" — and transpose, without losing accuracy, on to tape or punched cards suitable for processing by computer or other calculating media. Alternatively, if the data is in punched card or tape it can be transposed into tabular or graphical form for display, up to six variables being plotted together on a common base scale. Handling rates are normally in excess of 800 points per hour.

De Havillands feel that this service will meet a real need—perhaps among the smaller engineering and scientific firms—for the transposing of information speedily at low cost. It will be welcomed by firms using punched card or punched tape systems, who would otherwise have to install complex equipment themselves. The service centre has already carried out work for some eight firms, including the Central Electricity Generating Board and the UK Atomic Energy Authority. It is intended to provide an advisory service whereby firms

From graph to card
and back again

receive expert guidance on their problems, and it is anticipated that the centre will gradually build up its clientele until it is handling some thirty to fifty firms' data processing.

Planned for 1963

£250,000 for daily updating

The Norwich Union Insurance Society, which must rank as one of the biggest of life insurance offices, has also opted to install a Ferranti Orion computing system at its Norwich head office.

This system, the latest out of the Ferranti stable, will work initially on Norwich Union's pension schemes, a substantial part of their business. Next it will extend its scope to initiate a completely integrated system for individual policies. This will be a major undertaking, for Norwich have over 350,000 individual policies. A complete record of the policy will be held on magnetic tape. Processing policy tapes—as well as those for the company's pension schemes—will be carried out daily.

Programming and detailed planning should take a little over a year, and the computer should be operative by January 1963. The cost of the installation will be in the region of £250,000.

Erratum

Critical computer experts, who are apt to talk about the "transatlantic factor" inflating performance figures when they reach us from the States, will have raised their eyebrows when they read last month's report in Data Digest of the IBM computer Stretch. According to this Stretch could complete 100 thousand million arithmetic operations per second.

This should have read 100 thousand million *per day*. The mistake was ours—all twenty-three hours, fifty-nine minutes, fifty-nine seconds!

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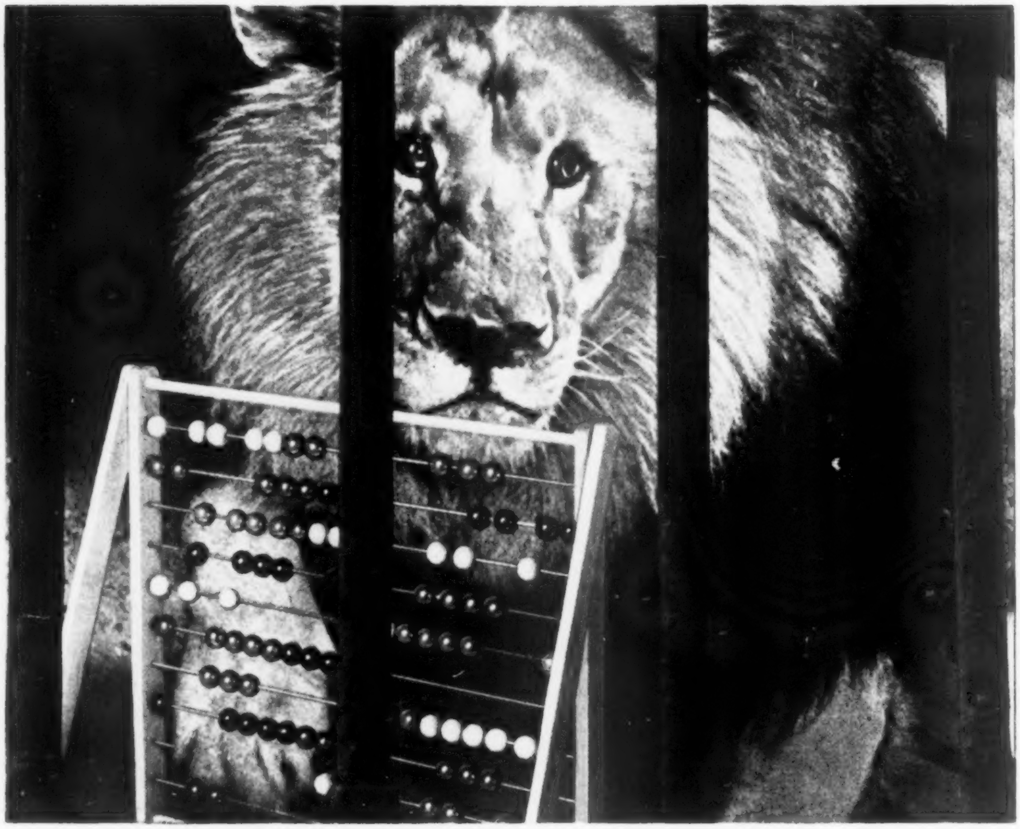

Actually, my cousin at Corby is the clever one

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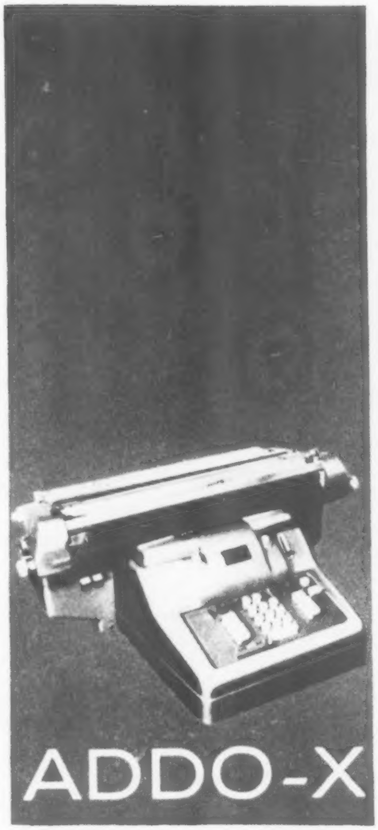
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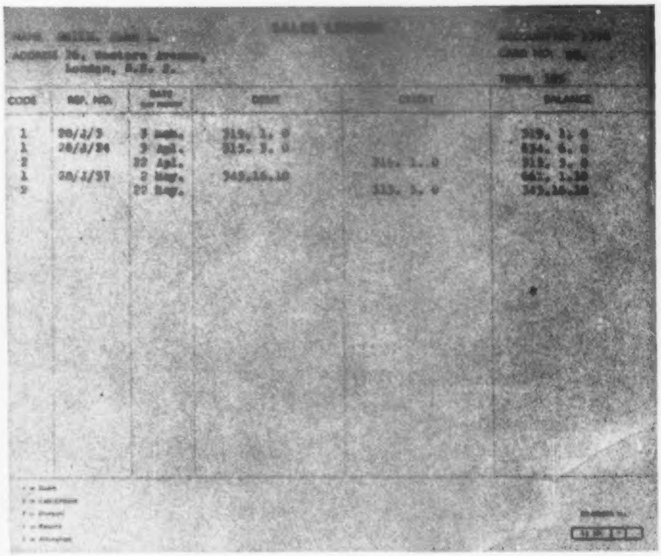

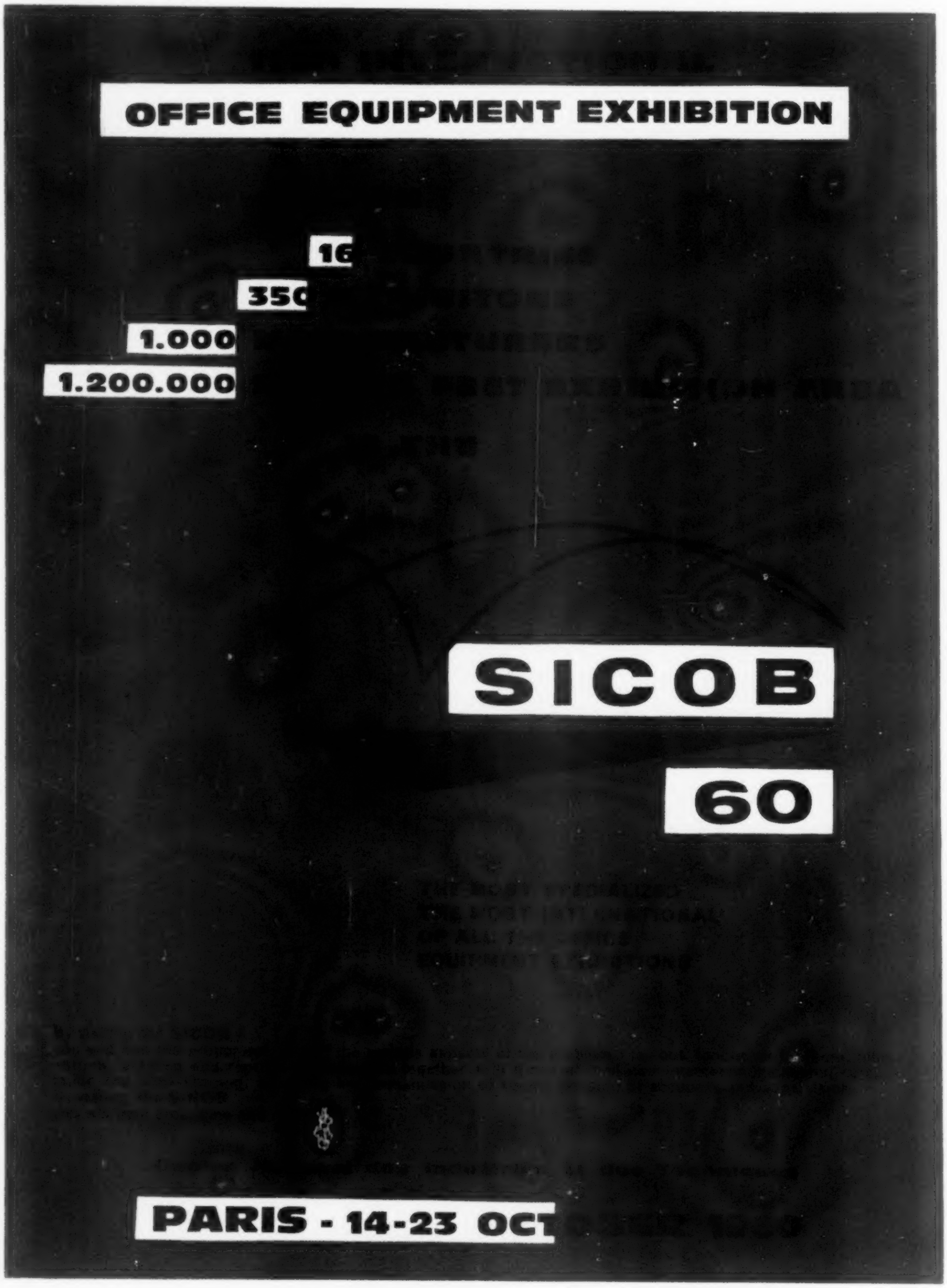
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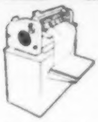
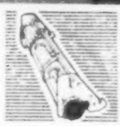
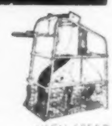

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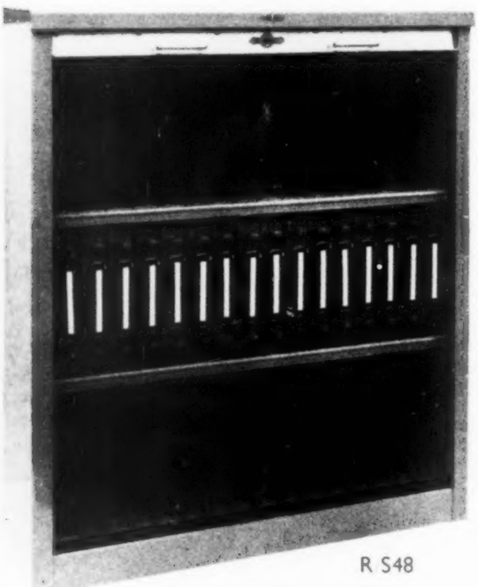

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Is Time-Sharing a Real Winner for Users?

Time-sharing on computers has suddenly become a much lauded concept, but will it really bring less sweat, toil and costs?

R Murray Paine

FROM time to time in the field of data processing as in other fields certain words become 'okay' and suffer increasing use by those who wish to be considered in the know. In the course of time a number of words, such as 'macro-programming', 'monte-carlo', and 'integrated' have earned the 'okay' cachet and passed into computer lore, and a current 'okay' word is certainly time-sharing.

Yet what does this term — heard so often — really mean? Is it a new technique? Does time-sharing benefit computer users in the sense that it gives better performance for less money?

First, let us look at a situation which could benefit from time-sharing so that we can obtain an idea of its various meanings. During a computer run a program instruction may call for an operation to be performed such as reading a card input or writing an output onto magnetic tape, or transferring information on a drum store — which will take much longer to perform than the normal internal instructions — such as add or test — and which will hold up the central computer or single control unit from performing another operation until this current operation is complete. It can mean that the costly central part of the computer — the arithmetic unit, the control unit, the fast store — is lying idle for a high percentage of the job time.

If some way could be found so that once one of these long external instructions had started, other instructions of the same program could be carried out by the central computer, then the machine would not be lying idle and the overall job time could be reduced. Or, to take a slightly different case, if in fact the computer during what would have been idle time could proceed with an entirely different program, then perhaps two programs could be run in about the time that would have been taken by one. In both these cases time is shared, either between two or more parts of the same program, or between two or more different programs — hence the use of the term time-sharing. For all practical purpose the expression 'parallel programming' means the same thing, since two or more operations are performed in parallel.

The simultaneous operation of several parts of the computer equipment, such as card input, calculation and printing, is not of course new. The use of buffers on such machines as the IBM 650, the Remington Rand Univac I, and the Emidec 1100, enabled several operations to be carried

out together. For instance, at a point in a program for these machines an instruction could be given to read a card into a buffer area, and this would allow the card reader to operate without holding up the central computer. The next instruction could be to send data to a print buffer and commence printing, and while the input and printing were proceeding, a third instruction could commence calculating on a previously read card.

This three-stage cycle of input, processing and output normally continues in harmony since one is essentially printing the results from card A, calculating on the data from card B, and reading card C. Normally to obtain the information from the input buffer or pass information to the output buffer, it requires transfers to and from the store of the computer, and this occupies a certain amount of time of the central computer during which no processing can be performed.

The principle of a buffer — for instance an input buffer — is to fill up slowly from a slow speed input device and then to discharge rapidly into the fast memory unit — rather like the operation of flushing a lavatory, where the cistern has been storing up water to present it in a sudden rush when required.

In this sense, therefore, time-sharing is not new and this has led experienced computer practitioners, such as Dr Andrew Booth, (1) to complain of a fuss about nothing. But time-sharing in its present-day sense is achieved by other means than buffers, and can be divided into two sections: the hesitation mode, and the priority interrupt, which are closely connected.

Hesitation Waltz

Designers of new computers have felt that buffers are costly pieces of equipment that are basically extensions of the machine's fast store which are not available for other uses and not used all the time. They have also felt that to limit this cost (especially when each peripheral unit had its own buffer) a limited, fixed size buffer has been used — for instance for magnetic tape 32 words in Pegasus, 60 words in Univac II, 198 characters in Emidec 1100. This fixed size might not really suit the nature of the data to be processed, which might call for variable length and much larger blocks for example a 250-word record followed by a 30-word record.

The answer of the designers of several machines — Orion, ICT 1301, KDP 10, Leo III, AEI 1010 — has been to do away with buffers as much as possible and use the fast store for the input/output

THE AUTHOR

31-year-old Richard Murray Paine majored out of Bristol University as an economist in 1953, and has spent the past seven years steeping himself in computer lore. He gained experience of programming and systems work with Ferranti, working on Pegasus and Perseus, then switched to Remington Rand and learnt about the Univac machines. Currently, he is with ICT working on magnetic tape subroutines and applications for their 1301 computer.

A member of the British Computer Society's council, Paine is no stranger to the conference microphone, was one of the authors of the book 'Electronic Business Machines', and keeps an eagle eye on everything that is happening in the computer business.

operations, without stopping the computer performing other operations. Let us see how this method of time-sharing works, using magnetic tape input as an example.

A program instruction initiates a magnetic tape reading operation and causes data to be transferred from the tape into the fast store of the computer. During the time before the first information is read from the tape, the computer is free to proceed with other instructions for this or another program. When the first unit of information (this can be several characters or a word) has been assembled from the tape, in a small special register associated with the tape control, and is ready to be transferred into the core store, the current program is caused to hesitate or pause. The data from tape are then transferred to the core store, and the current program is then free to continue from the point it had previously reached, while the next unit of information is assembled from tape. When this is ready for transfer, the current program is caused to hesitate, the transfer is carried out and the program again continues, and so on. Thus two operations - the reading from tape and other program instructions - are carried out at the same time, proceeding or waltzing from hesitation to hesitation, ensuring a high percentage use of computer time and using very small storage registers instead of large buffers. This automatic 'break-in' facility is provided entirely by hardware and the programmer does not have to remember where he is in the program every time it is caused to hesitate. He can write his main program almost without regard to the action of the magnetic tape transfers.

This method of time-sharing may mean that a single job is not performed any quicker but that it is performed with less equipment and probably at lower cost. In addition costly off-line devices are mostly eliminated. As it happens this buffer-less time-sharing is carried out on much faster machines than previously and therefore the total job time is also reduced. It should be understood that this is normally not because of the use of time-sharing through hesitation, but because of faster input/output equipment and a speedier internal operation. If however, several jobs can be run together the total time for all the jobs can be drastically reduced, and this is discussed later under 'priority interrupt'.

To illustrate the faster speeds of the new computers and their effect on the hesitation mode we can look at the new Ferranti Orion computer. This machine, along with several other systems, uses very fast Ampex magnetic tape units capable of reading or writing data at the high speed of 90,000 digits a second. But even so this rate is much slower than the computing circuits of the control computer, and therefore waiting till the end of a tape operation would waste computer time. Information is transferred from the tape via a special register to the core store in units of one word of eight characters. The eight characters take 89 microseconds to be read from the tape and assembled in the special register. The current program is then caused to hesitate at the end of an instruction or micro-instruction, and the eight characters are transferred to the core store in 16 microseconds. During this 16 microsecond hesitation information, of course, is still coming off the tape into the special register.

Thus every 89 microseconds the current program (of which the magnetic tape instruction may be part, or it may be another program entirely) is held up for 16 microseconds. This means of course that the current program will take that bit longer to complete, roughly 17 percent. If two tapes were running, one in and one out, there would be two 'break-ins' or 'hesitations' of 16 microseconds each every 89 microseconds; that is an increase in time to complete the current program of about 34 percent. The time lost to the current program can be considered roughly equivalent to the time required to transfer buffers to and from the core store in the system described earlier. It can be seen that if four magnetic tape units are operating simultaneously on this time-sharing method, the current program loses about two-thirds of the available time, so that there soon becomes a limit to the number of units that can be operated simultaneously. As has been said 'time-sharing is alright, as long as there is time to share'.

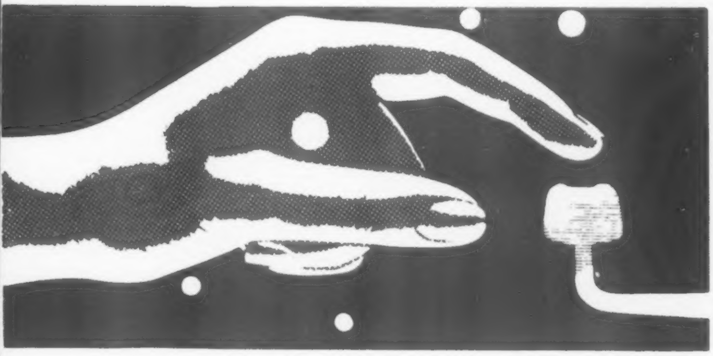
Variable Block-Length

Another aspect of the buffer-less mode is also illustrated in Orion - the variable block length facility which means less restriction on the layout of records. But to cope with variable block length of items on tape and the use of several tape units at once, quite a large fast store is required. Orion has a minimum core store of 4,086 words and it can be seen that the storage previously used for buffers is now being incoporated in the high speed memory of the machine itself. There may be little saving in cost to users but at least users have the consolation that the storage can be employed all the time and for differing purposes.

The variable block length facility is not quite so elastic as it might seem, because in practice one has to set aside certain areas of the store for input and output, though the size of these areas could vary from job to job. A limit has to be set otherwise a block may be read in which it is longer than expected and it will overwrite program or other data. The limit is larger than with buffers - for example 200 or 250 words but it should be remembered that the block size is not really completely variable. *continued on page 41*

A Preview of the

Business Efficiency Exhibition



Inevitably, with two or more Business Efficiency Exhibitions a year, few companies can spring novelties on the public at each exhibition. In this preview we have attempted to concentrate on equipment which will be *on show for the first time* at Olympia from 3-12 October, although some of the systems referred to in these notes have already been extensively described in previous issues of AUTOMATIC DATA PROCESSING

COMPUTERS

DUE to the levelling out of original production of new models a natural stage in computer development and due perhaps to the imminence of a computer exhibition of 1961, there are few computer exhibits. Ferranti will be content to show scale models of their Orion and Pegasus II; however, IBM will be showing their solid state computer, the 1620, for the first time. This machine (described in the December issue of AUTOMATIC DATA PROCESSING) is intended primarily for scientific purposes. More interesting to the business man is the 1401 Data Processing System, also on show at the IBM stand. The system comprises a computing unit, a card-reading punch with a reading speed of 800 cards per minute and a punching speed of 250 cards per minute, and also a printer, which hammers out 600 lines per minute, skipping where appropriate at a rate of 75 inches per second; the equipment will show its paces over such varied operations as invoicing, payroll and stock control. Other small computers in the exhibition are the transistorised National Elliott 803, equipped with the large magnetic film file system adapted from the 405, and the Burroughs F2000.

As we mentioned in our review of the Birmingham BEE, many accounting machines (for example the Adler and the Addo X ranges) are now equipped to punch tape as a by-product of normal calculating operations. There are, however, one or two interesting combined systems for computer input which merit attention.

INTEGRATED INPUT SYSTEMS

THE Creedomat is one of several ingenious systems which Creed will be showing. This equipment comprises a special electric typewriter and interconnected tape punch and reader unit. By this system typed copy and 5, 6, or 7 track punched paper tape can be prepared simultaneouly at the rate of 100 words per minute; also punched tape data can be translated into typed copy at the same speed. Facilities on the machines allow for the correction, revision and correction of tape, and also for the preparation of by-product tape for selected data.

On the Bulmer stand will be two integrated systems for input data. The first combines a Flexowriter with an arithmetic unit, thereby allowing the system to add, subtract and read out totals on the Flexowriter as instructed; ancillary equipment, punch, reader, and keyboard, allows two operations to be performed simultaneously. The other combined system, an Addo-X 247E add-lister with sterling multiplier, shown for the first time, which is integrated with a card punch, allows up to 9,999 items priced at £9,999 19s. 11d. each to be multiplied and the answer punched into a standard tabulating machine card, identifying information, code numbers being keyed in and automatically punched. Other models allow punched card information to be read directly into the machine, and also the columns of a line entry to be punched out into a tab card. Optimatic also have a card punch-cum-accounting machine as a single unit.

OUTPUT SYSTEMS

SOME really fast print-out machines are to be shown. The Creed 1000 is a high-speed serial (character by character) printer operating at 100 characters per second. With a variable print line of from 10 to 150 characters the equipment may either be used

as a direct on-line printer, or for off-line work.

Another new printer, of a slightly different kind, is the new Addressograph Transfer printer, which is able to operate from tabulator output and print out unit documents—loose-leaf ledger sheets at 500 six-line printings per hour, and statements, cheques, etc, at 7,200 multi-line impressions per hour. The Graphotype, operating from five or six channel tape, is a print-out mechanism which allows for the completely automatic embossing of Addressograph master plates.

A print-out mechanism of a more orthodox kind is the new ICT 915, an 80-column machine operating at a tabulating-listing speed of 150 cards per minute. The storage component of this machine allows information to be fed in from cards or counters and emitted to counters, card summary punch or print unit, the latter consisting of 120 individually controlled alpha-numeric print wheels, capable of selective grouping.

PERIPHERAL EQUIPMENT

SPEEDING-UP one stage of data processing usually results in the need to speed-up all along the line, and there are several new fast machines being introduced at the guillotining, separating and decollating stage. The Lamson Paragon form detacher, operating at a speed of 5,000 sets per hour, cuts and stacks multi-ply tabulating forms from 12 inches to a mere half inch deep, and with widths up to 18 inches. Another combined equipment for decollating multi-sets, removing one or several copies and carbons and feeding the remainder for guillotining is the Combisplit, which combines the Catlin Multisplit, a new automatic decollating unit, with the P1001 guillotine. Catlin will also exhibit an electronic guillotine (SV2002), synchronised with a xerographic printing unit. The SV2002 has photocell control, and can respond to dots, lines of type or similar marks, thus allowing forms of irregular length to be cut. With the SV2002 will be the Reelomat, an electronically controlled unit which will feed a continuous web of paper at exactly the required rate.

Fanfold are to show a composite unit of the new Fimafold Guillotine, the Fimafold Imprint Unit and the Carbon deleaver.

With this combine, static information can be imprinted on the forms before cutting, and also for five insertions of one-time carbon to be deleaved; thereafter the guillotine will cut into unit sets from half an inch to 18 inches in steps of one-sixth or one-eighth of an inch.

COMMUNICATIONS EQUIPMENT

THERE are two new data collection systems on show for the first time. The Collectadata, scheduled to have its premiere at the Birmingham BEE, now makes its appearance; the IBM Data Collection System 357, widely used in the USA, will also be on show. Basically, the systems consist of networks of input stations which relay information to a central receiving point.

Creed are showing a number of equipments developed from the Teleprinter 75. The projector printer prints out on five-inch-wide transparent Cellophane film, which can accommodate 45 printed characters in a line and 17 lines can be projected on the screen. This apparatus allows conference viewing of received teleprinter messages. The Creed 75 printing tape punch is designed for the automatic recording of telegraph messages and other data as code perforations and printed characters on standard five-track paper tape, operating at 100 words per minute.

In telephone communications the tendency is toward the cordless switchboard, giving combined external and internal communication facilities; of which there will be a number on show. A new answering system by Gate Electronics, the Ansacord, has several interesting modifications on previous models. First, a single instrument can be used to record messages received from three or four internal instruments; alternate pre-recorded messages can now be switched in, allowing for central dictation by day and for telephone answering at night.

PREPARING FOR BANK AUTOMATION

SEVERAL firms have been planning ahead for the proposed bank automation changes that are likely to take place. A B Dick will have a systems duplicating unit on show for imprinting and collating magnetic character cheques. The Bradma cheque personalising machine allows for each cheque in a bound book to be printed with the customer's name and account number immediately prior to issue. A more comprehensive display of banking equipment will be on the NCR stand where a National Pitney Bowes electronic cheque and document sorter, and Post-tronic semi-automatic book-keeping machine will be demonstrated.

The cheque sorter employs the E13-B magnetic character system, and has a normal working rate of 750 items a minute, handling mixed documents of different heights, widths and thicknesses. When a six-digit account number is used, 10,000 cheques can be placed in sequential order in only two hours, as compared to 30-40 hours by conventional methods.

FILING AND STORAGE SYSTEMS

THE emphasis of the new filing systems is towards compressed storage and immediate access, with suspended and pendulum lateral filing superseding the conventional filing cabinets. This can mean a saving of space of the ratio of seven and a half square feet to 30 square feet. Clear indication of location, and the ability to keep documents for long periods without tearing or creasing are other desirable features of suspended systems.

An electrically operated system for record card filing is to be shown by E N Mason. This system can file some 60,000 cards of dimensions of 12 by 10 inches, and allows for the operator to receive trays of record cards in a vertical position by activating a push-button switch on the mechanised card filing unit. Rotardex are bringing forward a new V file, which can be handled like a book or endways as a filing unit.

REPRODUCTION EQUIPMENT

WHILE developments in the duplicating and electrocopying field tend to be overshadowed by the revolutionary Xerox 914, improved equipment and innovations will be on show; for example, the new Ilford Azoflex, able to accept simultaneously two translucent masters, one for static and one for variable information. For microfilming Kodak have a Recordak 35 combined printer projector and processor, suitable for 35 mm. roll film and aperture cards. Electronic stencil scanning and photographic stencil making are also being shown.

Both Ansons and Copycat are to demonstrate new photocopying machines; Copycat's Dalcopier eliminates exposure adjustments and negative and positive materials.

from John Diebold and Associates New York

What the largest Single User has to say

The American Federal Government, which uses more ADP equipment than anyone else, has plenty of experience and hints to pass on to others.

SINCE the first large-scale fully automatic business data processing system was delivered to the Bureau of the Census in 1951, the Federal Government has been an active force in pioneering and perfecting business and engineering-scientific applications of ADP. Programs to assure best utilisation of equipment have been underway in the Bureau of the Budget for the past several years, and for longer periods in some departments. Today, the Federal Government is the largest single user of ADP equipment.

Salaries of federal employees engaged directly in electronic data-processing are expected to increase from an annual \$27 million in 1959 to nearly \$80 million by 1963—to say nothing of the projected 1961 total annual operating cost of \$345 million, and capital outlay of \$14.7 million About two-thirds of this is in the Department of Defense, comprising Army, Navy, and Air Force.

Under the initiative of the Bureau of the Budget, the Interagency Committee on Automatic Data Processing was established in 1957. It is composed of representatives from the twelve largest government departments, and chaired by the Bureau of the Budget. Its reports provide valuable ' bench-mark thinking ' for business.

In addition, there is a legislative ' watchdog ' over the whole problem of ADP in government—the

House Subcommittee on Census and Government Statistics, under the chairmanship of Representative John Lesinski, of Michigan. This subcommittee has, in recent years, been conducting extensive hearings on the impact of ADP on governmental operations—both in terms of increased efficiency, and employee job security. The published hearings form valuable source reading on advanced practice.*

Up-to-Date Progress Report

At a recent ADP symposium held by the Federal Government Accountants Association, the Honorable John A Beckett, Assistant Director of the Bureau of the Budget, reported on special projects and studies which have been completed, are now underway, or definitely planned. Here are some highlights:

▶ The Interagency Committee on ADP has appointed numerous task forces. These have already furnished the Budget Bureau with reports on such subjects as: rental versus purchase; inter-agency sharing of equipment; cost determinations; government-wide information exchange; guidelines for studies to precede ADP equipment acquisition; and studies of orientation and training.

▶ Last October, the Budget Bureau issued a call to all government agencies for an inventory of ADP equipment, with details on use and cost. These data will shortly be made available. The report on studies to precede acquisition of ADP equipment was sent to all departments last March.

Studies Underway

Rent vs. Buy. Mr Beckett advises that it is too early to predict the outcome of the study on rental vs. purchase. But he does say that there is increasing evidence that the practice of renting all ADP equipment as standard policy may need to be modified.

Orientation and Training. A government-wide programme will soon be formulated in orientation and training. An important feature is that additional training will be given to many top-level officials to provide a greater awareness of computer capabilities, and of the impact of ADP on their operations.

Computer Service Centre. The Budget Bureau recently undertook a study to see if there is a real need for one or more computer service centres in the government. If sufficient requirements exist, plans will be drawn up for an experimental service centre. This project should be finished by November.

Integrated Data Processing. In integrated processing accomplishments are not, perhaps, as significant as pending breakthroughs. Much is being learned by solving the simpler problems first. For example, information about manpower, money, and material are processed in one system and, at times, with production data added, are inter-related in ways that are far more meaningful to management.

Mr Beckett, however, points to 'bigger fish to fry,' in integrating systems for very complex management problems. For example, the navy, in its air programme, must procure, maintain, overhaul, convert, and assign aircraft to operating units. These operations have traditionally been performed by separate organisational units. And, to a large extent, each unit generates for itself the data it uses to manage its aspect of the navy air program. Time effort, and ingenuity are being put into solving the vast and complex co-ordinating problems which would arise from integration.

Inter-agency Integration. Inter-agency integration holds great promise. One example is in dealing with claims of veterans and their dependents for benefit payments under the GI Bill of Rights. These claims are processed by Veterans Administration; when approved, they are turned over to Treasury for cheques to be written; these cheques, stuffed in envelopes, are turned over the Post Office for delivery. Now they are voluntarily working together on their three separate systems, exploiting ADP to the full. In the near future, magnetic tape developed by VA for benefit payments will also be used by the Treasury for cheque writing. In preparing this tape, VA will insert address codes for mechanical presort of cheques by location, thus speeding the work of the Post Office.

Another example is the collaboration of Treasury and the General Accounting Office in reconciling Government cheques. This has resulted in appreciable savings in time and costs, and much higher accuracy.

Hardware Hypnosis. In pursuing its objective of providing an order flow of meaningful data *for use*, the Budget Bureau strongly cautions against becoming overly enamoured of hardware. It is not hardware that gets the job done. It is systems—conceived in breadth and developed with clear objectives in mind. 'He who gets a fixation on equipment—"Hardware hypnosis"—is in for trouble,' says Mr Beckett. 'Data development is *systems* oriented, not machine oriented.'

The Bureau of the Budget advocates no special or additional controls over individual ADP applications. The long-established normal budget review process will continue to be the primary means of reviewing ADP applications. The aim is to support sound programs in departments and their bureaux. The need for good ADP manage-

*Of special interest are the two published reports of the *Hearings before the Subcommittee on Census and Government Statistics of the Committee on Post Office and Civil Service, House of Representatives*, June 5, 1959, and March 2-4, 1960, obtainable from the United States Government Printing Office, Washington, D C.

ment at the departmental and lower level is constantly stressed.

Government ADP Procurement

Complementing the work of the Inter-agency Committee has been that of the special study groups. Thus, in order that all government agencies planning for, or using, data processing equipment should have the advantage of comparative information on terms and conditions of manufacturers' contracts, an analysis of all contracts was prepared by the joint Department of Defense-General Services Administration Contract Negotiating Committee. This analysis reflects a major accomplishment of the Committee for the fiscal year 1960, *viz* the agreements with manufacturers regarding the standardisation of ADP contracts, particularly the industry-wide replacement of the 'availability concept' with 'use concept'; the guaranteed standard of performance before acceptance of equipment; provisions for application of liquidated damages for manufacturer's failure to meet equipment installation commitments; and the option to renew for the succeeding fiscal year if deemed desirable.

The Committee's comparative analysis is now being distributed by the General Services Administration to the civil agencies, and by the military departments to all commands. We are indebted to Major-General Robert W Ward, Director of Management Analysis in the Office of the Comptroller of the Army, for information on this activity.

The Government Hearings

It is interesting to note, on examining the governmental hearings, how the shadow of Dr Parkinson disturbs the Subcommittee. As watchdog it is fearful that despite purported savings, reductions in total employment and expenditures will somehow fail to emerge. But as a body sensitive to public reaction, it would apparently like to see dramatic economies without redundancies *ie*, it would like to place its faith in natural wastage and reassignments.

Thus, in the March 2-4 report, the chairman emphasises: 'The equipment should not be allowed to become gigantic "papermills" merely because it can process information at a terrific rate of speed . . .' But at the same time, the chairman's opening remarks also state that: 'While the Subcommittee has no indication that office automation, as such, is posing a serious threat to employees, it is felt that this is an area that should be kept under careful scrutiny. We want to determine what safeguards have been taken and are now in effect, and if more are needed, what they should be.'

Representatives of employee groups appearing before the subcommittee evinced surprisingly mild reactions. Typical testimony was that of James Campbell, President, of American Federation of Government Employees. 'There could be no valid objection to the installation of labour-saving devices. . . . However, the same degree of planning that is devoted to the possible use of machinery should be devoted to the disposition of personnel, so that where they are no longer needed, in one activity they can be trained and brought into other activities. . . . We have received very few complaints from our members . . . by and large the agencies have made a reasonable effort to take care of the displacement of personnel.'

The hearings highlighted these significant points:

▶ In general, careful pre-planning for personnel appears to be done. Most elaborate, perhaps, is that of the VA.

▶ In Government, turnover is surprisingly high—22 percent a year, over-all. Attrition has thus been a big help.

▶ Ever-continuing expansion of services has cushioned the personnel problem. (But here perhaps, the shadow of Parkinson looms.)

A Lead for Industry

Of all the examples drawn from government, that of the Veterans' Administration is perhaps most illuminating for private industry. The first VA large-scale computer was installed in the Philadelphia district office in July, 1959, and conversion should be completed during 1961. In addition, there is a medium-size random-access computer in each of three offices. The second large-scale computer was installed in the Chicago office late in 1959, and is to become the hub of all data processing activities.

Edward R Silberman, Assistant Administrator for VA Personnel, testifying before the Sub-committee, cited the following benefits: 'Annual administrative expenses for our insurance program in fiscal 1949 were over $50 million, while in fiscal 1959 the expenses were less than $25 million. [Yet] the accounts serviced in 1959 were slightly in excess of the number of 1949. Conversion of our benefit payment activities for compensation, pension, vocational, rehabilitation, and education, should result in an estimated saving of 312 positions by the end of fiscal 1960.'

'In addition, as a result of our electronic computer operations, in just veterans' benefits of insurance, it is estimated that by fiscal 1962 there would be a further reduction of 1,259 positions.'

Mr Silberman strongly underscores the VA's concern with the human problems, and described what he termed the agency's 'Administrative Magna Carta' covering the following points:

VA established basic principles and policies on an agency-wide basis, to govern the fair treatment

of all personnel affected. It keeps current accurate data on the employment situations in VA stations around the country—how many people are affected, types of jobs and their geographic location, dates of conversion, and the like. Department heads must advise managers concerning the occupational categories and approximate numbers of employees directly affected at each station by conversion to ADP, not later than six months prior to the conversion date.

Better job opportunities will be made available to present VA employees as a result of automation. Training programs will be initiated well in advance of conversion, for special skills needed for ADP, and for other VA positions where existing skills can be utilised.

The need for reassignment actions will be anticipated in sufficient time to take full advantage of opportunities for re-deployment. Employees adversely affected will be given at least 90 days' notice. (Civil Service regulations call for only 30 days.)

VA will determine jointly, with all management levels, the areas and stations in which employment will be frozen, to provide maximum transfer and placement opportunities within the agency. Managers of affected stations will be notified of the applicable employment freeze at least three months, and preferably six months, prior to the effective date of conversion.

Reduction of 1,200 positions by the computer program is expected to be phased out with negligible redundancies. During conversion, overtime is used to meet the workload, and temporary help is employed for critical personnel needs, to lessen the personnel problem later. The VA will give some 100 persons training in programming, after selection by aptitude tests. Over 500 have been trained on clerical procedures for ADP, and over 400 have been receiving specialised training in input and output documents.

Individual companies can well take a leaf out of the VA's book, and do as elaborate a job as they can in pre-planning, and in employee communication. (Detailed exhibits on the VA employees program are incorporated in the Hearings.)

RESEARCH TODAY—I

Machines of Tomorrow

The first of two articles to report on the considerable research effort that computer manufacturers are currently financing.

Keith Bean

DEVELOPMENT of new servants for business and industry is as busy a field of research as any in the world today and in the field of electronics it is perhaps the most rapidly moving.

The pace is so hot that a period of three or four years is regarded as a long haul, phrases like 'a major breakthrough' are commonplaces in the conversation of the back-room boys and many of the designers are dedicated not merely to the improvement of known techniques but to evolving quite different, revolutionary systems.

Such machines could be within sight in three years or so. What will they be like? What lines are the research men working on?

And—just as important to the businessman—is the work on the machines being matched by operational investigations to ensure that the new creations will be not esoteric monsters but practical productive instruments which commerce and industry can fully exploit in the hard, brass-tacks matter of more efficient and profitable business?

Let us look at the research first. The big drive in this country for people to work in design teams is evident in the many advertisements in the national papers—men interested in fundamental research, men who will exploit the processes of pure physics to make better machines, designers keen to take up the challenge of fitting new devices into ultra-high-speed circuits, logical designers, programmers who are more interested in improving computers rather than solving specific problems.

The British effort, fittingly, is comparable to most countries', but because of the enormous costs there is naturally a great deal of international collaboration, even by companies which are not linked in their capital structure.

The ultra-high-speed switching elements recently announced by Elliotts, for instance, are based on work done at the University of Illinois by Professor Wolfgang Popplebaum and Neil Wiseman on the Atomic Energy Commission contract.

The Southampton laboratories of IBM United Kingdom have their work co-ordinated with fifteen laboratories abroad—in Zurich, Amsterdam, Stuttgart, Paris, Stockholm and ten in the United States.

In this work, pooling of minds and resources has many advantages, IBM has found. Often, due to differences in training and methods, a scientist from one part of the world takes a completely different approach to a problem from his colleague elsewhere. And there are problems too in applying computers to national environments. Computers in Britain, for instance, are required to do calculations in pence, shillings, pounds and guineas, in contrast to decimal currency.

Personal visits lasting weeks or months, symposia, exchanges of technical reports and of films all help to build fruitful contact between staffs in different countries.

The British IBM laboratory at Southampton, in addition to work on high-speed computers, is doing advanced research in the field of thermoelectric cooling for computers.

This technique, in contrast to such electromechanical devices as fans and air conditioners, has no moving parts. It makes use of special semiconductor materials which become cold as a current is passed through them. Obviously it could be a big trouble-saver, space-saver, cost-saver.

At the company's Zurich laboratory, which has scientists and engineers from England and half a dozen other countries, one of the main projects is basic research on thin magnetic films, a possible high-speed method for providing computer 'memories.'

Projects in Germany include growing crystals with special electrical properties, development of special electronic circuits, and the investigation of high-speed mechanical and electro-mechanical devices.

Work in the Amsterdam laboratory is devoted to the complex problems associated with automatic feeding and transporting of paper documents and to machine reading of printed data from documents.

The French laboratory is working on data transmission, the high-speed automatic transmission of information between computers located at great geographical distances—a boon to all industries having a central office in one city and branches or plants or agents in other areas.

An earlier development, the data transceiver, transmits data on punched card to another transceiver miles away by phone and seconds later the second transceiver punches a duplicate card for use in further computer processing.

The latest work carries this development a step further. A central computer, working at a much higher speed, directly transmits and receives messages to or from locations which may be thousands of miles away. The recently announced US Sabre system—a vast electronic reservations system employing a giant IBM 9090 computer to be installed by American Airlines—is an example of high-speed data transmission using telephone lines.

Providing European firms with the benefits of this development is not easy because of technical characteristics of the varied European telephone systems.

The French laboratory is now working with the other four European laboratories and government authorities on the problems—another example of joint research where a new technique from one country is being adapted to specific situations in other countries.

At various IBM laboratories on both sides of the Atlantic work is in hand on projects concerned with basic research and theoretical scientific exploration—for example, cryogenics, automatic translation of languages, and solid-state physics—and progress is communicated to all other laboratories.

When such a project is ready for practical application it is taken over by a development engineering team which brings it to final form as a saleable product.

The enormously wide range of subjects which demand scientific and technological investigation—and the geographical distribution of the work—are characteristic of the vast research and development effort which the industry as a whole is making.

It will mean faster, more efficient, more campact and more economical machines and systems for the service of modern business.

Astonishing developments seem just a little way ahead.

It has been said—and by no means purely in jest—that office machinery makers will be giving away computers free in a few years as an inducement to buy the peripheral equipment, input and output machines and the like.

How wild or how sober are such statements and how near are we to reaping practical benefits in our automatic data processing systems from the new techniques such statements imply?

Some of the answers must await a second article. (Next month: Machines like Minds.)

PLANNING AND PRACTICE—9

Good times on computers

How to make estimates of timing for computer applications

J M Thornley, *Urwick Diebold Ltd.*

IN considering installing a computer it is important to know whether the computer will handle the work in the available time. Although the subject of timing may lack some of the dynamic interest associated with electronics, one thing that is never dull is the realisation, after a computer has been ordered, that there will not be enough capacity to handle the intended applications. The purpose of this article is to help to prevent such a rude discovery, first, by emphasising the importance of accurate timing estimates and by indicating common oversights; and secondly, by providing criteria by which one can evaluate whether a worthwhile timing estimate has been made; and, finally, by describing an outline method of estimating the time required to handle the load.

Timing in this context is simply the process of estimating in advance the number of hours per day, week, or month that will be required to run a given application, or group of applications, on a computer system. Since the estimate must be made before the system is designed in detail and since the effective performance of a computer is normally directly related to the design of the system, there are obvious complications. It is, however, possible to arrive at a timing estimate that is sufficiently accurate to indicate whether a given computer system can do the job in a prescribed period of time.

There are many examples of the agonies resulting from poor timing estimates, and reviews of company data processing plans as well as proposals from equipment manufacturers show that the current errors tend to fall into several classes.

1—*Carelessness.* This type is the easiest to detect, because it is obvious that a thorough analysis has not been made. A few properly chosen questions will generally indicate that, if timing estimates have been made, they have not been thoroughly considered, and they have been based on rough overall rules of thumb. A great many computer orders today are still placed with no timing analysis to act as a base, either because there is confidence in the manufacturer's statement that his machine can do the work, or because there is no real conception as to what the machine will be required to do when it arrives. The remedy for this is clear. The first step is to know clearly what one plans to do on the computer system before placing the order, and then to insist that every proposal contains a detailed estimate of time required for each application *which can be verified.*

2—*Attempts to qualify an inadequate machine.* It is rare that a manufacturer will purposely attempt to sell a machine that he knows is incapable of doing the work required, for the results will eventually do him more harm than good. However,

even accepting this, there are a great many possibilities for error. The first is the possibility of encroaching on time reserved for future expansion. Most firms installing computers seek to plan several years ahead, and if their data processing volume is increasing, they will sensibly seek to be employing their equipment at something below capacity for the first few years. The vagueness of this reserve provides leeway for incorrect timing estimates that eventually result in encroachments on all or part of the reserve. Then, as volumes increase, overtime or additional equipment is required to handle it. Another area of 'loose timing estimates' is in the 'secondary' operations concerned with editing and checking. By making estimates based on running times, and by ignoring or minimising the time needed for checking, re-reading, and editing operations, time can be significantly underestimated. This is particularly applicable when comparisons are being made between several machines, some of which have built-in checking features which the others do not have.

3—*Partial approach.* This is an extremely common form of error that is usually the responsibility of manufacturer and customer alike. It consists of basing timing estimates on the one major application, and leaving 'enough' reserve time for the others. The main question that goes unanswered in such cases is of course: 'what is enough?' There is some justification for this approach if the detailed estimate is really made for the most complex and time-consuming operations, and if these are accurately timed. Generally, however, if they have been sufficiently analysed for timing to be accurate, there should not be too much additional work involved in making timing estimates for the other applications. The real and oft-repeated danger is to make accurate estimates for the 'paper work' applications, and then to leave a reserve time for the 'grey area' that consists of production planning, production control, and often stock control as well. The reason for this approach is obvious; the paper work areas are much easier to define, and in many cases they are already being handled with punched cards.

4—*Misunderstanding of the assignment and inexperience.* A great many timing errors arise because there is no clear indication of what is expected of the computer system. A recent example is the case of an American motor car company that was considering the equipment required for its spare parts inventory control. A system was designed and a computer almost ordered, when management suddenly realized that, as a result of vague instructions, the planned system would not provide the daily reporting on which management was relying. (It is of course the customer's responsibility to indicate clearly the requirements of his system, and the manufacturer's duty to make proposals based on these requirements, subject to any changes agreed with the customer.)

AN APPROACH TO THE TIMING PROBLEM

The correct approach to timing estimates is to make an estimate for each computer run required; this can be done without having designed a detailed system, although it must be based on a thorough analysis of work to be done, the volumes involved, and a rough plan of the system. The steps involved in a good timing estimate are as follows:

1. Calculate the maximum input rate.
2. Check that this rate can actually be obtained in view of the size of the file against which it is to be processed, and modify the input rate as required.
3. Check that this modified input rate is reasonable in relation to the calculations to be performed.
4. Determine if any calculation time can be overlapped with file search times.
5. Determine if any calculation time can be overlapped with input feed time.
6. Determine if any calculation time can be overlapped with output time.
7. Check the frequency of the various input and file transactions.
8. Work out the time required for each run on the basis of maximum figures.

For each run, there must be a clear appreciation of the work to be done as well as the nature and amount of editing and checking, based on the characteristics of the particular equipment being timed. As a result, it will be useful to bear in mind the following list of operations which are important in applying the correct method of computer timing:

1. Timing of Input-Output

Input-Output Card Handling Time. The time required for the manual feeding of cards to the input hopper is often overlooked. Experience with delays caused by the input hopper running out of cards or by an overloaded stacker stopping the run indicates that card-reading time should never be calculated at more than 85 per cent of capacity. Another common error is to base input time calculations on the card-reading rate rather than the card-handling rate. Since cards must be subjected to certain mechanical handlings before they can be read, as much as 30 per cent of the card-reading time may be unavailable for calculation time.

Program Loading Time. When the program is maintained on punched cards, feeding the program can require up to 20 minutes. If it is on

magnetic tape, loading, feeding, rewinding and unloading the program tape can account for 10 minutes or more.

Input-Output Editing Time. Few computer systems provide adequate facilities for automatic editing of input-output or file data. Accordingly, the user must provide the programs necessary to develop input and output data into the precise form required. Such initial and final editing programs may require as much as 50 to 75 percent of the actual productive computer running time.

2. Timing of Processing

Iteration Control Time. Iteration or loop calculations are frequently utilised in order to save memory storage space. Adequate time must be allowed for setting up and controlling the work.

Programmed Arithmetic Checks. Programmers frequently use programmed arithmetic checks and the balancing of 'jibberish' totals as a necessary guard against system or component failure. This is particularly true when dealing with magnetic tape and can add considerably to program running time.

High Speed Memory Usage. Programmers will frequently base timing assumptions upon access and performance times of the computer for data stored in the rapid access store. Such an assumption overlooks the need for frequent transfers of data and instructions between high speed and slower storage units.

3. Timing of Magnetic Tape Operations

Tape Handling Time. Manual handling time must be calculated for operations whenever tape storage is used. For example, sorting one tape on four tape units requires up to five tape loadings and five tape unloadings. Even if one assumes a very skilful operator and allows a minimum time of two minutes per loading or unloading, this additional time can add up quite appreciably.

Magnetic Tape Start-Stop Times. Magnetic tape handling time is often computed at quoted read-write speed which seldom includes necessary start-stop times. Many computers require a stop on each block when a tape is written and allowances should be made for start-stop times.

Tape Rewind Times. Since it is sometimes possible to 'flip-flop' magnetic tape units, overlapping the rewind of one tape with the processing of the next, analysts frequently forget that the last tape has nothing with which to be overlapped. Further, various processing situations may require more tape stations to permit flip-flopping than are available. Magnetic tape rewind time normally requires from four to seven minutes.

Tape Sorting Time for Multi-Tape Files. When the file to be sorted exceeds one tape length, a common error is to base sorting time calculations on the number of items to be sorted rather than on the number of items per tape.

In such cases the number of actual passes required for sorting can be significantly underestimated. For example, if one reel of magnetic tape has a capacity of 10,000 items and 20,000 items are to be sorted, a calculation based strictly on the number of items indicates that 16 passes will be required. However, the number of passes required for complete sorting is actually 30.

4. Timing of Random Access Memories

Address Calculation Time for Random Access Stores. Unless a firm is willing to modify its file classification system to conform to the addressing system of the machine, the computer must normally perform arithmetic calculations in order to transform file numbers into an acceptable address. Many system analysts assume that manufacturers' statements of access time are all-inclusive and so overlook this factor.

Random Memory Searching Time. Some random access store addressing systems are only approximate in that they specify an area of memory capable of storing two or more records rather than a single and unique record location. Accordingly, once the area in which a file item should be stored is located, a further search must be initiated to find the specific record. Unless the storage system has a built-up table-lookup operation or search function a separate search program is required for this which frequently requires considerable time per individual record.

Random Memory Overflow Searching. Since a given area of a store sometimes has more records associated with it than it can actually store, excess records or overflows must be stored elsewhere. In searching for these items the machine may well go through two or more complete searching cycles before the correct record is located.

5. Timing of Operations

Volume Assumptions. Many systems are designed and timed for average volumes. While this may provide 'average' run times, it does not provide an indication of the capacity of the system to handle peak volumes.

Inquiry Times. Almost all data processing systems must provide a means for locating information in order to satisfy random and generally unpredictable inquiries. Locating the desired information may require an entire sequence of tape changes, program feeding and output printings unless the occurrence is anticipated and proper procedures are incorporated in the system.

Automatic Data Processing Systems and Equipment Under Scrutiny

A survey of all the possible *means* for establishing and improving data processing methods in all kinds and sizes of companies. Part I of the survey, which will be spread over this and the October issue, deals with computing systems.

SCOPE OF THE SURVEY

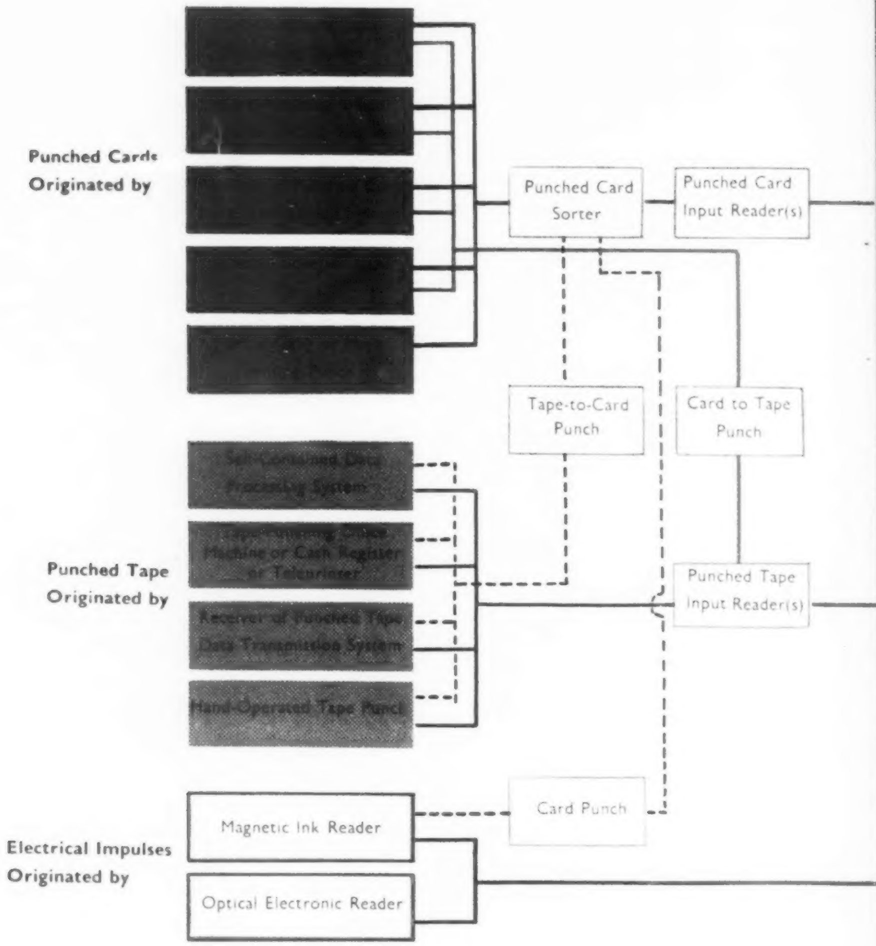
It is by now fairly clear that automatic methods for processing business data will increasingly appeal to the businessman. The range of even present equipment (and the applications it can be put to) is so wide that the benefits held out by automatic data processing cannot be ignored. This survey is an attempt to provide a shop window. The nature of the goods displayed—which begin with machines to produce the 'raw material' of data processing and end with equipment for handling the results—is outlined in part in the diagram on pages 30 and 31.

It must be emphasised that this is *only* a diagram—formalised, generalised, and to some extent restricted—to provide a composite picture of how a very large range of products can be (but *not* collectively) interlinked. It is not a schematic representation of any one system but more like a map, which shows all the places and the roads which lie between them, but does not indicate the best route. Also it has not been possible to incorporate into one diagram all the equipment covered by the survey—for instance, data transmission and facsimile systems and self-contained data processing systems which do not require a computer.

As a concession to space limitations and for the convenience of the reader, this survey is published in instalments. Yet it cannot be emphasised to strongly that this format does not advocate a fragmentary approach. Even the smallest data processing system must be conceived as a whole. To act otherwise would be as absurd as trying to assemble a human body limb by limb, add a head, and hope to produce a properly functioning man.

Where possible, we have given some indication of prices. But these must, of necessity, be considered only as rough estimates. The addition of more storage capacity to a computer, or even another register to an accounting machine, can add a significant percentage to the price. In some

SOURCE DATA



cases, therefore, the prices given are average; in others, where two figures are quoted, these represent the probable upper and lower limits.

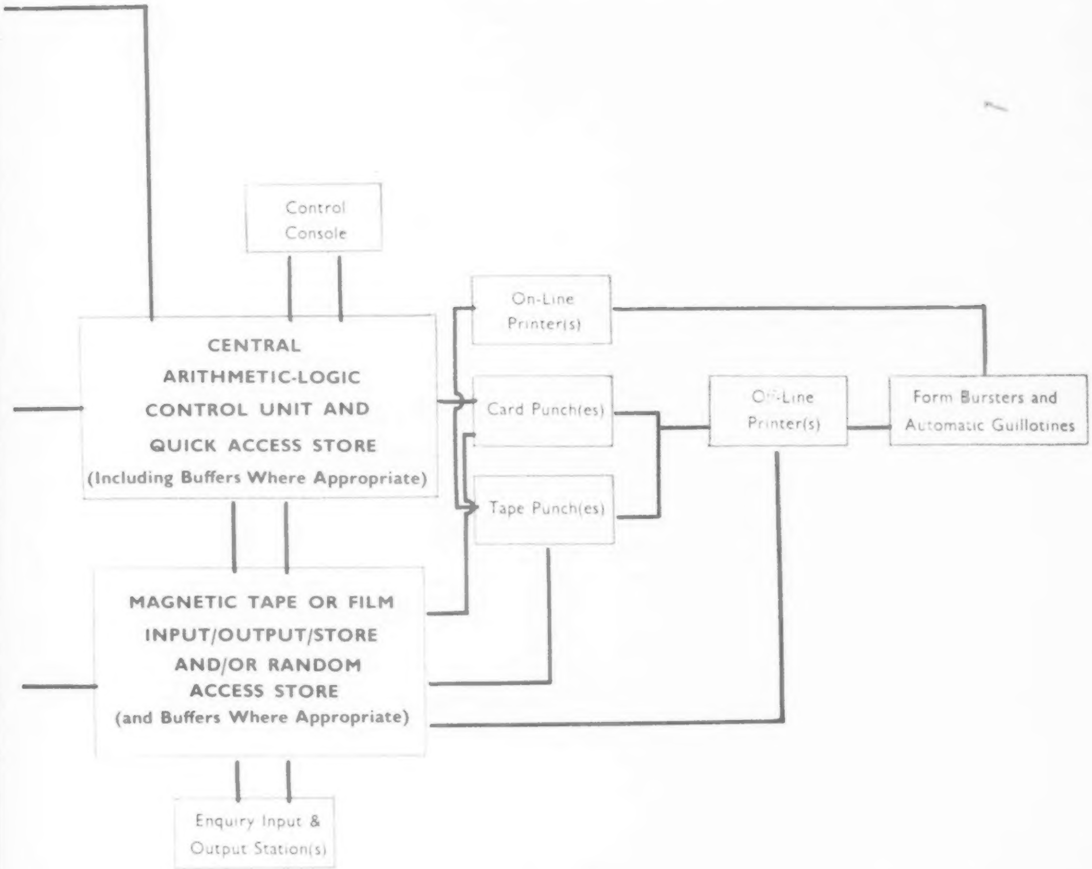
Finally, though every attempt has been made to cover accurately all relevant equipment available on the British market now or in the very near future, some will, inevitably, have been omitted, and some details may already be out of date. Data processing equipment is rather like aircraft—by the time specifications are made public and production begins, many new developments are under way. And these occur so fast and so frequently it is not always easy to keep up with them.

ORDINARILY it would be illogical to attempt to separate an electronic computing system into its component parts. Used properly, a computer is only one part of an integrated system, which begins with data preparation and ends with the efficient distribution of the results of the processing.

Nevertheless, because the scope of this survey makes publication in one article impracticable, an arbitrary division has had to be made. The first two parts will therefore deal with central computing, control and storage units.

A look at the diagram on pages 30 and 31 will show how artificial this division is. Considering a computer without its input and output units, or even in the wider context of how the original documents will be produced, is as absurd as trying to conceive of a brain without a communicating

This chart has been drawn up to give a bird's eye view of the survey, and to show how the kind of equipment to be reviewed logically fits into a data processing complex. It has, of course, not been possible to indicate on the chart — for space reasons — *all* the equipment that can be employed — for example, data transmission and self-sufficient data processing systems; however, these will nevertheless be covered in the survey.



nervous system. Therefore, to rationalise the procedure as far as possible, indication has been made, in bare outline, of the means of feeding and extracting information to and from the central units. Fuller details will be published subsequently in the sections dealing with this equipment.

Information presented in this instalment of the survey will be useful as an indication of what can be done in the way of computation—in terms of volume, speed, versatility and storage capacity. Later instalments will show the various ways in which data can be prepared, transmitted automatically from place to place, and fed into the central units; the forms in which it can emerge after processing (and the equipment concerned in these functions), machinery for dealing with the vast amounts of paper thus produced, and storage equipment for accessories. Working thus, from the centre outwards, makes more sense than listing the means of feeding information to entities as yet undescribed.

Some Notes on Specifications

The following brief notes help to clarify the form of the survey.

1. Computers not now in production (though often still in active use) are not reviewed separately but are mentioned in descriptions of their successors.

2. In most cases, no mention has been made of the control console of the machine, or methods for automatic checking of computations. Though

both these aspects are important, they have necessarily been omitted for the sake of brevity.

3. Size classification is, almost without exception, that given by the manufacturer. Since it is virtually impossible to draw an arbitrary line where size is concerned, one person's estimate is as good as another's. It is, therefore, least controversial to use the maker's classification.

4. In some instances, magnetic tape may be used only for storage and is accessible only through the computing unit. In others, it may be used for off-line input and output through use of reading and writing units with direct communication to tape. For this reason, and because we wished to preserve a uniform format in specifications, the blanket heading 'input/output/external storage' is employed.

5. Delivery, in some cases, has been quoted as within a specific period; in others the term 'as required' is used. 'As required' means that the computer will be available within the time required for preparation for its arrival. Use of this term does *not* imply a longer waiting period than when an exact date is given.

What the Figures Mean

Considered in a vacuum, an electronic data processing system is nonsense. Statistics and specifications only begin to take on a significant meaning, when considered vis-a-vis actual work requirements.

An arithmetic speed of x microseconds, considered out of context, means nothing. The context, in this case, is not only how many calculations are required in any operation the user intends to perform on the computer, but – equally important – the machine's internal 'housekeeping' arrangements.

To illustrate the last point, here is an example based on one of the computers reviewed below. The machine's input is punched cards, passed at a speed of 450 per minute. A card is read every 133 milliseconds. Of this time, 3.4 milliseconds (2.55 percent) is used by the central computing unit to control the card; the remaining 97 percent is available for useful computation. Similarly, the computer's read-punch (input-output) unit reads and punches a card every 400 milliseconds. Of this, only 3.4 milliseconds (0.88 percent of time) is needed for control purposes.

Thus, if both units are handling cards at maximum speed, 96.6 percent (100 minus 2.55 minus 0.85 = 96.6 percent) of the card passage time is available for effective computation. This we will call 'payload percent' of the machine.

It will readily be seen how important this figure can be. The payload percentage of any particular system can only safely be established in conjunction with the manufacturer. But it is one of the more important tools for assessing relative merits of different systems.

Another aspect of 'housekeeping' is the versatility of the computer in controlling peripheral equipment. For a user who wishes to employ several input-output units simultaneously, it could be disastrous if the computer were incapable of fast switching and independent control of the various units; or had an inadequate buffering system with the result that computation was held up by data 'queuing' in store for release to the comparatively slow electro-mechanical output units.

The practical value of storage capacities only becomes apparent when these are considered in relation to other capacities in the machine; and when some estimate is made of factors like the amount of information which could usefully be kept on an electronic file; the speed with which details must be located; and the ease with which they can be extracted in a form useful to the executive.

'Time-sharing' is a concept as yet little explored, though provided for in many of the new computers. But it may be highly relevant in forward planning. A system, for example, might begin by working on clerical procedures. Later, it might be required to include mathematical work for the research department. Two applications of this kind, one requiring voluminous input and output, the other relying chiefly on much computation, could very well complement each other in a time-sharing machine.

Both operations could be performed simultaneously in far less time than it would take to work both programs separately. And most computers are designed in such a way that the 'housekeeping' of time-sharing need not be incorporated into the program, the computer automatically looking after this. (An article on time-sharing appears on page 16 of this issue.)

Programming procedure is another relevant consideration when choosing a computer. Many machines now can themselves do part of the programming, thus reducing the load on highly qualified mathematicians. These 'autocode' procedures do not necessarily offer the most efficient way of using the computer. But where there is computing time to spare, and/or skilled programmers are in short supply, autocodes can be a great help.

Large and Medium size Computers

1010—(Maker—Associated Electrical Industries Ltd)
Size: Medium to large
Price: Typical starting price, £170,000
Applications: All data processing in business and industry
Delivery: As required.

EXTREMELY fast, 1010 handles data at a speed of over 500,000 characters per second. Compact (it is completely transistorised), capable of utilising up to 32 peripherical units of any make, flexible in application, it is nevertheless not expensive.

Time-sharing facilities are an intrinsic part of 1010's design. A system known as 'data scanning' permits all the peripheral units to operate simultaneously; a special sequence of machine instructions—the 'program switch'—automatically shares the time of the program control unit between a number of stored programs. There is therefore no necessity for dovetailing when writing programs.

Another function of the program switch is to allow interruption and interrogation, whereby urgent work can be given priority over any current program(s). When the rush matter has been dealt with, the computer automatically 'finds its place' in the temporarily abandoned programs and completes them in the normal way.

Plug-and-socket connections, suitable for any type of equipment, are used for peripheral units. Data are passed in a standard format of one word at a time. Thus, an initial installation using only six to eight input-output units may, at any time, be extended by adding others with their associated controls. This system will also permit replacement of equipment which may, eventually, become obsolete by the most up to date available.

SPECIFICATIONS

Arithmetic Speeds:
Addition and Subtraction: 20 microseconds
Multiplication: 160 microseconds
Division: 260 microseconds

Internal Storage:
Immediate access ferrite core. 2,048 or 4,096 x 44-binary-digit words. Access time: 3.5 microseconds. Cycle time 10 microsec.
Magnetic drum. 8,192 x 44-binary-digit words. Transfer time, 20 milliseconds for 32-word block.

Input/Output/External Storage:
Input: High speed paper tape reader for 5, 6, 7 & 8 channel tape. Up to 1,000 characters per second.
High-speed card reader for all 80-column cards. Card-by-card speed 340 per minute; continuous 400 per minute.
Output: High-speed paper tape punch. 300 characters per second; for 5, 6 and 7 or 5, 6, 7 and 8 channel tape.
Appropriate types of card punches
Samastronic line printer. 300 x 140-character lines per minute
Xeronic line printer. 5,000 lines per minute on paper up to 26 inches wide.
Storage: Decca Twin-Tape magnetic tape units, each with 2 independent decks each with read-write facilities. Capacity 10,000 blocks x 32 words of 44 binary digits each per 2,400 feet of tape.
Ampex tape decks. Capacity 30,000 blocks per second.

Maximum number of input/output units: 32, including magnetic tape

205—(Makers—Burroughs Adding Machine Ltd)
Size: Medium
Price: Comprehensive commercial system about £180,000
Applications: Commercial and technical—*eg.* instalment loan accounting, utility billing; linear programming, engineering, aircraft construction.
Delivery: 6 months

THOUGH described by the makers as a medium-size system, the 205 has many characteristics found in large installations. These include: maximum flexibility in choice and use of input-output media; internal storage of 40,800 digits; independent simultaneous operation of peripheral units—which permits time-sharing on programs; fixed or floating point arithmetic (the latter an optional facility).

A comprehensive 205 system consists of four components: central computer; basic input-output, using paper tape input, paper tape and typewriter output; a Cardatron-controlled input-output system using punched card input and punched cards or on-line tabulator output; and a comprehensive magnetic tape system.

The Cardatron system comprises a control unit which handles up to seven input-output equipments using standard 80-column cards and all capable of working simultaneously. The system, by incorporating its own extensive editing and buffering equipment, effectively speeds computer operation by looking after a large part of the 'housekeeping' associated with its functioning.

Two types of magnetic tape store are available—single reel or Datafile (large capacity bin-type units). Respective capacities are 400,000 and 2,000,000 words per unit. A maximum of 10 of either type may be used, the entire group being, in each case, controlled by a single unit.

Autocode program procedures may be used for the 205, and a large program library is available.

SPECIFICATIONS

Arithmetic Speeds:
Addition and Subtraction: 1 millisecond
Multiplication & Division: Average 9.3 milliseconds

Internal Storage:
Magnetic drum; 4,000 x 10-digit-and-sign words. Quick-access loops; 80 words. Access time to main memory, 8.5 milliseconds; to quick-access, 850 microseconds.

Input/Output/External Storage:
Input: One 6-channel paper tape reader; speed 540 characters per second.
One Cardatron unit controlling up to 7 punched card input-output stations. Completely buffered; 6 format bands on each unit for editing. Reading speed 300 x 80-column cards per minute.
Keyboard, for supervisory control.
Output: One 6-channel paper tape punch; 60 characters per second.
Punched cards (see Cardatron above). Five format bands on each unit for editing. Punching speed 100 x 80-column cards per minute.
Line printer, completely buffered, hooked directly to any output station. Five format bands on each unit for editing. Speed 150 x 120-character lines per minute.
Supervisory printer—modified Flexowriter. 10 characters per second.
Storage: Tape storage unit—reel storage. 2,500 feet per reel, 2 lanes per tape. Capacity 400,000 words per tape.
Datafile—bin tape storage. 50 tapes, 250 feet each. 2 lanes per tape. Capacity 2,000,000 words per Datafile.
Speeds for both: 60 inches per second; density 100 digits per inch per lane.

Maximum number of input/output units: One each paper tape input and output; one Cardatron unit; one magnetic tape control (10 single-unit or Datafile units).

220—(Makers—Burroughs Adding Machine Ltd)
Size: Large *Price:* £300,000 to £600,000
Applications: Commercial data processing of all kinds; all types of scientific and industrial calculation.
Delivery: 6 months.

A COMPREHENSIVE 220 system comprises the following five components: central computer; basic input-output system using paper tape input, paper tape or typewriter output; a Cardatron input-output system (see description of Burroughs 205); comprehensive magnetic tape system; high-speed Dataprinter, for use on- or off-line and incorporating facilities for its own editing, interrogation, tape merging, and independent storage of static details. Future developments are likely also to permit direct linkage of the 220 system with equipment working with magnetic ink encoded documents.

As in the 205 system, there is a choice of two types of magnetic tape unit. Very flexible, the magnetic tape system's characteristics include: use of blocks varying freely in length between 10 and 100 words; use of two types of command—'search', bi-directional and optionally limited to a partial word field, and 'scan'—uni-directional and also with partial-word-field operation. The scan system may be used, for example, to extract from magnetic tape all records with a particular condition in common, say a credit balance.

The completely transistorised Dataprinter system consists of two main components—storage-control unit and high-speed printer. The latter works at speeds varying from a maximum of 1,500 lines per minute for numeric and 1,250 for alpha-numeric details. Other Dataprinting characteristics include: two-tape merging facilities; selective printing from tape (information on tape can be compared with pre-set controls and only pre-selected details printed); side-by-side print-out of two forms similar in format but with differing data; complete automatic error-check.

SPECIFICATIONS

Arithmetic Speeds:
Addition and Subtraction: 1·5 microseconds.
Multiplication & Division: Average, 2 milliseconds.
Internal Storage:
Ferrite core store; 2,000 to 10,000 words. Access, 10 microseconds.
Input/Output/External Storage:
Input: Up to 10 paper tape readers; 7-channel code; 1,000 characters per second.
Punched cards—Cardatron unit controlling up to 7 punched card input-output stations. Complete buffering. Six format bands on each input unit for editing. Read speed 240 x 80-column cards per minute.
Keyboard, for supervisory control.
Output: Up to 10 paper tape punches; 7-channel code; 60 characters per second.
Cardatron unit (see input). Five format bands on each output unit for editing. Punch speed 100 x 80-column cards per minute.
Line printer, completely buffered, hooked direct to any output station. Five format bands on each unit for editing. Speed 150 lines per minute.
Dataprinter high speed printer, fed by magnetic tape, usable on- or off-line. Print speed up to 1,250 x 120-alpha-numeric lines per minute.
Up to 11 supervisory printers: 10 characters per second.
Storage: One magnetic tape control unit to handle up to 10 of either type of storage unit: (1) Reel unit, 3,500 feet per reel, 2 lanes per tape, 6 channels per lane; variable block length, 10 to 100 words; density 208 digits per lane; speed 120 inches per second; capacity per reel, 1,376,000 words. (2) Datafile bin storage. 50 tapes of 250 feet each per bin. Other characteristics as for (1) above. Capacity 4,650,000 words per Datafile.
Maximum number of input/output units: See individual entries.

Visible Record Computer—(Maker—Burroughs Adding Machine Ltd)
Size: Medium *Price:* About £100,000 (complete system)
Applications: Banking, hire purchase and financial accounting, building society and savings bank accounting.
Delivery: First deliveries 1962.

HIGHLY specialised, the Visible Record Computer is designed for use with a complete system for handling documents encoded with magnetic ink. It provides an entirely automatic method of reading, collating and entering information on individual ledger cards.

The system has four components: magnetic ink document sorter-reader; ledger processor; arithmetic, storage and control unit; control console.

The document sorter, which can also be used independently, is directly linked to the computer to feed in details read electronically (via magnetic ink) from written documents. The ledger processor combines output and main memory functions. Output is channelled direct to conventional ledger cards which themselves possess a storage device (inbuilt magnetic strips) containing up to seven words of data and control instructions. These cards are kept in account number order; fed automatically to the computer where their store contents are read and acted upon, new information entered. Inactive cards are skipped automatically.

Central computer is an arithmetic unit which operates in decimal or directly in sterling; has a quick-access core store of up to 100 words of 12 digits each; can use up to 12 program drums fitted with punched mylar tapes containing, between them, 2,520 program steps.

In addition to the normal controls, the control console embodies a manual keyboard.

SPECIFICATIONS

Arithmetic Speeds:
Addition and Subtraction: 8 milliseconds
Multiplication: 8 milliseconds plus twice the sum of the multiplier digits.
Division: Not given.
Internal Storage:
Magnetic core. Up to 100 words of 12 digits and a sign each.
Removable mylar program tapes, up to a total of 12. Maximum program steps 2,520.
Input/Output/External Storage:
Input: Burroughs B.101 sorter-reader. Speed, dependent on computer program, up to 1,560 documents per minute.
Ledger cards, automatically fed and selected. Speed governed by computer up to a maximum of 200 cards per minute for inactive cards.
Ledger cards—manual feeding.
Output: 160-column line printer, for journal printing only.

Speed 180 lines per minute. Up to 4 copies each of one or two independent sheets.
Ledger cards automatically stacked in magazine or ancillary hopper.

Storage: Magnetic stripes on individual ledger cards. Capacity up to 84 digits of data and control information.

Maximum number of input/output units: All, as listed above.

GAMMA 60 (Maker—De La Rue Bull Machin Ltd)
Size: Large *Price:* £450,000 to £1,000,000
Applications: Large-scale commercial data processing projects of all kinds; technical and scientific problems.
Delivery: Precise date not quoted; details given in response to specific enquiries.

DESIGNED for time-sharing, Gamma 60 is a large and flexible system which can simultaneously process several commercial and/or scientific programs. System is controlled by a unit known as the 'program distributor' which allows work to proceed simultaneously on different stages of the same program as well as permitting concurrent running of two or more programs. The number of input and output units which may be employed is, for practical purposes, unlimited; all can work at once. Thus very high speeds are achieved.

Input may come from punched cards, punched tape or direct from magnetic tape; output may be via the same kinds of media and by high-speed printers, several of which may, if required, work simultaneously.

Gamma 60 embodies a unit known as the 'data translator'. This edits incoming details into machine language, re-translates this (after processing) for output, edits data for the printer to give correct format, etc, and edits data used in the arithmetic unit to ensure economical use of storage space.

Internal storage is by magnetic core with capacity varying from 16,384 to 131,072 alpha-numeric characters; access time is 11 microseconds. The magnetic drum, with average access time of 10 milliseconds, gives storage for an additional 102,400 alpha-numeric characters. Any number of magnetic tape storage units may also be added.

SPECIFICATIONS

Arithmetic Speeds:
Addition and Subtraction: 100 microseconds.
Multiplication: 300 microseconds.
Division: 600 microseconds.

Inernal Storage:
Magnetic cores; 16,384 to 131,072 alpha-numeric characters. Access time 10 microseconds.
Magnetic drum; 102,400 alpha-numeric characters. Average access time 11 milliseconds.

Input/Output/External Storage:
Input: Punched card reader; 300 cards per minute.
Punched tape reader (5- or 8-channel); 300 characters per second.
Output: Card reader-punch; 300 cards per minute.
Paper tape punch; 25 characters per second.
Character printer; 300 x 120-character lines per minute.
Storage: Magnetic tape units; 3,300 feet long. Capacity 10,800,000 decimal digits or 7,200,000 alpha-numeric characters each unit. Transfer speed 22,500 decimal digits or 15,000 alpha-numeric characters per second. Speed 75 inches per second.

Maximum number of input/output units: Unlimited.

503 (Makers—Elliott Bros (London) Ltd)
Size: Medium. *Price:* £100,000 upwards.
Applications: Industrial, scientific and general mathematical work involving large volumes of computation.
Delivery: First production model, January 1962.

DETAILS given here are based on preliminary information which, presumably, might be modified later.

Aim has been to reduce costs while giving high working speeds. Transistorised, and therefore small in size, 503 has a simple design. Costs have been reduced further by using a program code developed for previous machines (the National-Elliott 803, for example).

Arithmetic, which is very fast, may be done in fixed or floating point notation. There is a single level very fast access store for all instructions and data. Priority processing system ensures that arithmetic and input-output units always operate at full speed.

Since it is anticipated that 503 will be used in control applications, provision is made for attaching hundreds, or even thousands, of input-output devices direct to the computer. Also, a net of the maker's 803 computers can be electrically connected to the 503 which will act as a central processing unit.

Other input-output devices include: paper tape and card readers and punches; high-speed printers.

SPECIFICATIONS

Arithmetic Speeds:
Addition and Subtraction: Floating point, 8 to 15 microseconds; fixed point 8 microsecondsr.
Multiplication: Floating point 15 to 25 micoseconds; fixed point 18 to 28 microseconds.
Division: Floating point 25 microseconds; fixed point 28 microseconds.

Internal Storage:
Immediate access magnetic core. Basic capacity 4,096 or 8,192 words; additional blocks of 4,096 words can be added. Access time 4 microseconds.

Input/Output/External Storage:
Input: 7-track paper tape reader, 1,000 characters per second.
Punched card reader; 400 cards per minute.
Process inputs through commutator switches and analogue-to-digital converters.
Output: 7-track paper tape punch; 100 characters per second.
Card punch; 100 cards per minute.
Line printer; 900 lines per minute.
Digital displays and on-line printers.
Process outputs.
Storage: Magnetic tape units. Transfer rate 270,000 bits per second. (11.4 milliseconds per 64-word block).

Maximum number of input/output units and magnetic tape storage units: Unlimited.

EMIDEC 1100 (Maker—EMI Electronics Ltd)
Size: Medium *Price:* £100,000 to £300,000
Applications: Commercial data processing—*eg.* hire purchase and credit sales accounting, stock and production control, payroll, labour costing.
Delivery: As required.

SMALLER of the two Emidec systems, the 1100 is no less versatile. Fully extended, it can reach medium size; but is constructed in such a way that a small beginning can be made.

Basic installation may comprise only four pieces—control console, central computing unit, card punch, card reader. To these may be added, step by step or *en bloc* up to four magnetic drum stores, magnetic

The Bull 300 DP Series

(a fully synchronised unit system)

flexible, fast and expandable

Basic Elements	*Basic Speeds*
*Card Reader	300 cards per min.
*Card Reader/Punch	300 cards per min.
*Arithmetic Unit (× ÷ + −)	300 cycles per min.
*Printer	300 lines per min.
*Programme Unit	

All the elements are linked through the programme unit which co-ordinates the whole system and enables parallel processing of data.

Input/output speeds may be doubled by the addition of further units.

A second programme unit can be attached, increasing programme possibilities and enabling even further expansion of input/output units.

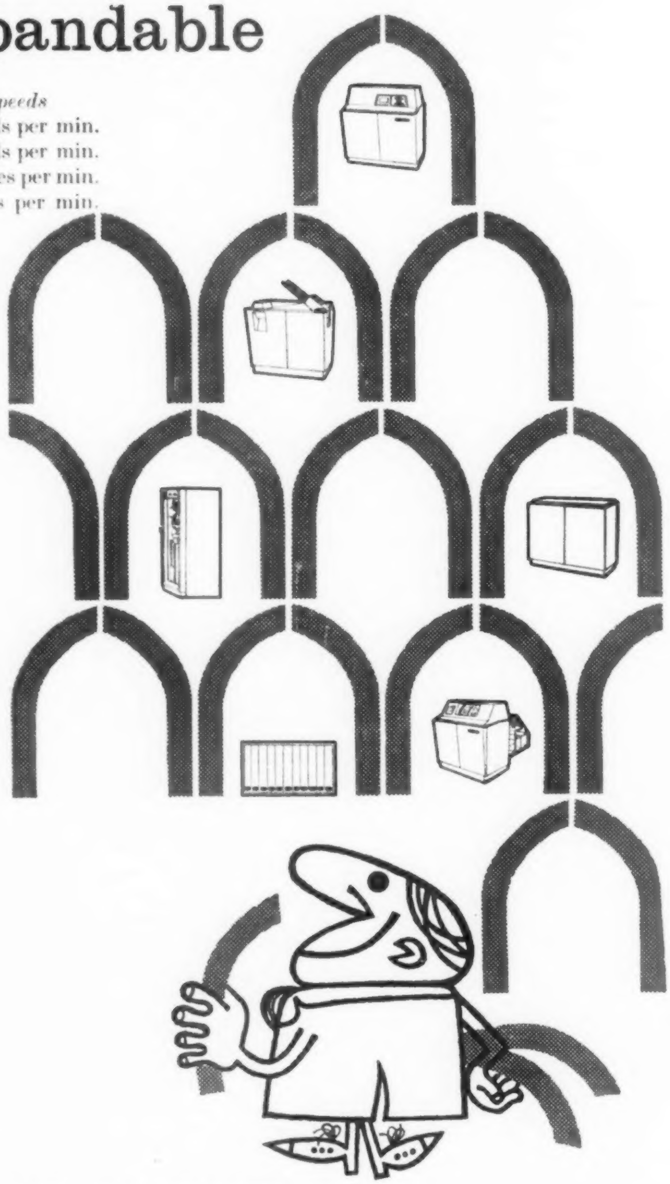
The 300 DP Series will expand into an electronic system with the incorporation of one or more of the following units, as required:

- *Gamma 300 Computer
- *Magnetic Drum Extension
- *Multi-Selector
- and Magnetic Tape Units

The Gamma 300 Computer with Drum will bring to the system the advantages of even faster arithmetic units, together with storage of up to 200,000 decimal digits. Should greater capacity be needed up to eight magnetic tape units can be added.

An integrated system is maintained with the addition of each unit to suit requirements. Here then is Data Processing Equipment with the widest possible range of expansion which will be an asset to every organisation with data processing problems.

The first order has been placed for a large installation which is due to be delivered in the early Autumn of 1961.



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ADF8

tape decks and a line printer. Paper tape equipment may be used in addition, or as an alternative, to card punches and readers. Each piece of peripheral equipment, of which a total of 16 can be used (including magnetic tape) in any combination, has its own built-in buffer store. Additions can therefore be made without modifications to the computing unit.

Emidec 1100 is completely transistorised. Designed specifically for commercial use, it has facilities for simultaneous input, output and computation; uses a program code designed with an eye to business applications; and has a control desk which has been simplified as far as possible.

The arithmetic unit operates in the parallel mode in fixed point arithmetic. Internal storage is an immediate-access magnetic core. A backing store of 4,996 words on magnetic cores can also be added where rapid drum transfer times are important.

SPECIFICATIONS

Arithmetic Speeds:
Addition and Subtraction: 140 and 150 microseconds, respectively.
Multiplication: 1260 microseconds.
Division: 1440 microseconds

Internal Storage:
Magnetic core. 1,024 x 36-binary-digit words.

Input/Output/External Storage:

Input: Paper tape reader for 5, 6, 7 or 8 channel tape. 300 characters per second; 24-character buffer store.
Punched card reader. 400 x 80- or 65-column cards per minute; 198-character buffer store. Reader can be used on- or off-line
'Fred' electronic reader. Speed dictated by mechanical equipment associated with it.

Output: Tape punch for 5, 6 or 7 hole tape. 33 or 300 characters per second, according to model. (Page printing interpreter can be hooked to either.) 99-character buffer store.
Card punch. 100 cards per minute; 198-character buffer store.
Line printers 300 or 3000 lines per minute according to model. Former has 198-character buffer store and can be used on- or off-line.

Storage: Up to 4 magnetic drums, total capacity 8,192 to 65,536 x 36-binary-digit words. Backing store of 4,096 words on magnetic cores can be added where fast transfer times are important.

Maximum number of input/output units: Up to 16, including magnetic tape units.

EMIDEC 2400—(Maker—EMI Electronics Ltd)
Size: Medium to large *Price:* £250,000 to £750,000
Applications: Commercial data processing—*eg.* order processing and stores control, payroll, management statistics, including sales forecasting.
Delivery: As required.

CONSIDERABLY faster than the Emidec 1100 the 2400 also has facilities for using nearly twice as many peripheral units. All-transistorised, it is designed on the unit system, *ie.* additional input, output and storage equipments can be attached without modification of the central computer.

All peripheral units (and the processor) are designed to operate from high-speed magnetic tape. Under a master control plan, all units in the system operate independently, information being exchanged by tape-switching. This operation, during time-shared programs, is incorporated into the master program; but on other occasions, switching may be carried out manually through the control desk.

An interesting feature of the 2400 system is the provision made for entering data direct from a typewriter keyboard to magnetic tape. A network of up to 112 off-line keyboards can be used. These incorporate self-checking and error-correction features. The equipment has an independent power supply.

Basic internal storage is fast random access ferrite cores with a capacity of 4,096 words which can be extended to a total of 16,384 words.

An autocode program system can be used.

SPECIFICATIONS

Arithmetic Speeds:
Addition and Subtraction: 25 microseconds
Multiplication: 110 microseconds
Division: 300 microseconds

Internal Storage:
Magnetic core in stages of 4,096 x 36-bit words to a total of 16,384 words. Core store buffer 2 x 35-bit words. Up to 4 buffers can be used in each installation.
High-speed diode-capacitor. 64 x 36-bit words.

Input/Output/External Storage:

Input: Up to 112 typewriter keyboards to magnetic tape (off-line)
5 or 7 hole tape reader, 300 characters per second
Punched card reader, 300 x 80- or 65-column cards per minute
Magnetic tape (see storage below)

Output: Paper tape punch. 30 characters per second.
Card punch. 100 x 80- or 65-column cards per minute
Line printers 300 or 3,000 lines per minute, according to model. (Former can be used off-line.)
Magnetic tape (see storage below)

Storage: Fast stop-start magnetic tape 1 inch wide, 2,400 feet long. Six data tracks, 4 check tracks, 2 timing tracks per channel; 2 channels per tape. Transport speed, 200 characters per second. Read-write speed 20,000 characters per second. Capacity 5,000,000 alpha-numeric characters per reel.

Maximum number of input output units: Up to 30, excluding tape and off-line typewriter keyboards.

DEUCE I, II, IIA—(Maker—English Electric Ltd)
Size: Medium. *Prices:* Mark I: £45,000 upwards.
Mark II: £50,000 upwards.
Mark IIA: £60,000 upwards.
Applications: Mark I: chiefly scientific problems, and some commercial data processing. Mark II, IIA: small and medium size commercial data processing, scientific and technical problems.
Delivery: As required.

DEUCE was originally designed purely for scientific applications. Then, realising the need for wider scope, the makers introduced the Mark I. This, though primarily still for scientific use, can read and punch 64 columns of 80-column cards. This development virtually doubled input and output speeds of the original machine. A further concession to data processing users was the opportunity to fit magnetic tape storage units.

In the Mark II, heavier emphasis was placed on commercial work. This computer has a combined input-output unit, completely buffered, which reads and punches all columns of 80-column cards. Magnetic tape storage is standard.

Distinguishing feature of Mark IIA is the increased capacity of the high-speed storage—50 percent higher than that of the Mark II. Otherwise, the machine

is the same as Mark II. This larger quick access store means that programs and data may be used in larger blocks, with the effect that less reference is needed to backing store.

Arithmetic unit of all Deuce computers works in fixed-point notation, though floating-point sub-routines are available. One single and one double length accumulator are provided; the latter may be used as two halves.

Programming system of the Deuces is said to be so simple that much of the work can be done by juniors. Program input is in binary form on punched cards.

In addition to the fast access store, there is a backing store comprising a single magnetic drum. A second drum may be added. Magnetic tape decks are mounted in pairs; up to four pairs may be used with any model.

SPECIFICATIONS

Arithmetic Speeds (for all three machines):
Addition and Subtraction: 32 microseconds.
Multiplication & Division: 2 milliseconds.

Mark I

Internal Storage:
Quick access mercury delay lines. Total capacity 402 x 32-digit words. Access time 16 to 496 microseconds.
Magnetic drum: 8,192 words; second drum may be added if required.

Input/Output/External Storage:
Input: 80-column punched card reader, utilising 64 columns. 200 cards per minute.
(Optional) High-speed paper tape reader; 450 or 850 characters per second.
Output: 80-column card punch, utilising 64 columns; 147 alpha-numerical characters per second.
(Optional) High-speed paper tape punch (speed not given).
Storage: Magnetic tape, housed in pairs on single console. Total up to 4 twin units.
Maximum number of input/output units: 1 input, 1 output; up to 4 twin magnetic tape units.

Mark II

Internal Storage: (see Mark I).
Input/Output/External Storage:
Input: Card punch-reader using all columns of 80-column cards. Speed with input-output operating synchronously, 100 cards per minute; when operating independently, 200 input, 100 output per minute.
Paper tape reader for 5, 6, 7 or 8 channel tape (if 8 channel used, only 7 are read); 850 characters per second.
Output: Card reader-punch (see input).
Storage: (See Mark I).
Maximum number of input/output units: (see Mark I).

Mark IIA

Internal Storage:
Mercury delay lines. Total capacity 626 x 32-digit words. Access time 16-496 microseconds.
One or two magnetic drums; 8,192 words each.
Remaining details as for Mark II

KDP 10—(Makers—English Electric Ltd)
Size: Medium to large. *Price:* £180,000 to £600,000.
Applications: All forms of commercial data processing.
Delivery: 18 months.

CONSIDERABLY more versatile and flexible than any of the Deuce computers, and newer, KDP 10 has, from the first, been intended for commercial data processing. While Deuce machines are essentially computers, KDP 10 is a fully integrated system. Unlike the Deuces, KDP 10 is fully transistorised; is also considerably more powerful.

Components include: program control unit, containing arithmetic and control elements; random access high-speed magnetic core store; control console; tape selection/buffer unit controlling up to eight magnetic tape units; paper tape reader; on-line monitor printer (tape-punching electric typewriter); high-speed printer.

Up to 62 magnetic tape stations may be used, each group of eight under its own controller. In addition, off-line card-to-magnetic-tape and magnetic-tape-to-card converters (respective speeds, 400 and 150 cards per minute) may be used. An electronic editing unit, which allows editing to be done by the converter, may be employed.

Basic capacity of the magnetic core store is 16,384 alpha-numeric characters; this may be expanded (without change to the basic system) to a maximum of 262,144 characters. Each character location is individually addressable.

The high-speed printer has an on-line speed of 600 lines per minute. The same unit, with an electronic control unit and tape unit, may be used off-line, when it can achieve 900 lines per minute.

SPECIFICATIONS

Arithmetic Speeds: Not given.
Internal Storage:
High-speed random access magnetic core; in increments of 16,384 characters to maximum of 262,144. One character or 4 in parallel can be addressed in 15 microseconds.
Input/Output/External Storage:
Input: Paper tape reader (7-channel); 1,000 characters per second.
Punched cards, used with off-line card-to-magnetic-tape converter; reading speed 400 per minute.
Output: Line printer; 600 x 120-character lines per minute on-line; off-line, with control unit and magnetic tape unit, 900 lines per minute.
Punched cards, used with off-line magnetic-tape-to-card converter; 150 cards per minute.
Monitor printer, 10 characters per second; simultaneously punches 7-hole paper tape.
Storage: Up to 62 magnetic tape units in groups of 8 with controller. Read-write time 33,333 characters per second.
Maximum number of input/output units: On line: one paper tape punch, one monitor printer, one high-speed printer. Up to 62 tape units.

KDF 9—(Maker—English Electric Ltd)
Size: Medium to large. *Price:* Probably £125,000 upwards.
Delivery: Probably 2 years.
Applications: Medium-to-large commercial data processing work; medium-size scientific and technical problems.

AS the KDF 9 system has only very recently been announced, no precise specifications are available. Details given here are compiled on advance information which may, presumably, be modified later.

Salient features include: very high-speed operation; extreme simplicity of programming and ease of translation from any pseudocode; wide range of fast and flexible peripheral units employing all standard media; optional automatic time-sharing; expansible high-speed store in units of 4,096 words up to 32,768 words of 48 binary digits. The system will be entirely transistorised.

For practical purposes, there will be no limit to the number of peripheral devices which can be con-

nected to the system. The number of electro-mechanical units which can operate together is unrestricted; up to eight tape units will work simultaneously.

Typical operating speeds are: 1 microsecond for fixed-point addition; 5 to 14 microseconds for multiplication; a maximum of 4 microseconds (48 binary places) for shifts. Various features in design combine to make operating speed even faster than appear from these figures, the makers say.

PERSEUS—(Maker—Ferranti Ltd)
Size: Large. *Price:* About £250,000
Applications: All types of commercial work; 'industrial mathematics' such as those used in operational research.
Delivery: As required.

As Perseus is a valve computer, it seems probable that in the near future it will be superseded by later Ferranti systems. A large computer, it was designed specifically for commercial use, but the makers envisaged a need for industrial mathematical applications by the same users. Programs for a single installation may therefore include both these types of work.

Perseus accepts punched card or paper tape input; but output is restricted to a line and/or character printer(s). External storage comprises up to 16 magnetic tape units.

SPECIFICATIONS

Arithmetic Speeds:
Addition and Subtraction: 234 microseconds.
Multiplication and Division: Autonomous—carried out simultaneously with other operations.
Internal Storage:
Nickel delay lines. Total capacity 32 blocks x 32 x 72-binary-digit words.

Input/Output/External Storage:
Input: Paper tape readers for 5 and/or 7-hole tape. 200 characters per second.
65- or 80-column card reader. 300 cards per minute.
Output: Samstronic line printer. 300 x 140-character lines per minute.
Teleprinter. 10 characters per second.
Storage: Up to 16 magnetic tape units grouped in fours, each group with one control which contains a buffer. Tape ½ inch wide in multiples of 600 foot-lengths to maximum of 3,000 feet. Capacity 2,380,800 alpha-numeric characters each full reel. Rewind time 4 minutes.
Maximum number of input/output units: Input: 2 tape or 1 card reader. Output: 1 or more line printers or teleprinters.

In this section of the Survey devoted to large and medium size computers, machines are described in the alphabetical order of their makers. So relevant machines of Ferranti, IBM, ICT, Leo, National-Elliott, Remington Rand and Standard Telephones will be reviewed next month when this section will be continued.

continued from page 18

Priority Interrupt

A second feature of time-sharing is the ability for two or more distinct jobs to be performed using a ' priority interrupt ' technique. That is when one job is held up because it has to wait for data from the drum, or card reader or tape unit etc, the machine switches to another job. When the data for the higher priority job are available, the second job is automatically interrupted, and the computer continues with the higher priority job. But it remembers where it was in the second job so that it can continue that when the occasion arises. While the second job is being performed it may itself be affected by the hesitation mode time-sharing as data from magnetic tape for the first job is transferred unit by unit into the fast store.

To illustrate this feature let us assume that three separate applications are being processed by the computer—payroll, invoicing and sorting—all requiring separate files on magnetic tape, and the first two requiring new data from punched cards and output on line-printers. The payroll job, which we will assume to have top priority, starts, but when an order is given that will cause the central computer to be idle and only concerns the peripheral units, the central computer can switch to another task. The next one in priority may be the invoicing job and the computer will continue to process this until either (a) the payroll data are available, when the invoicing will be interrupted and the payroll resumed or (b) the invoicing job has to wait, *ie.* while printing is done, leaving the central computer idle, when the lowest priority job, sorting, will be processed. The sorting operation in its turn may be interrupted by data becoming available for the payroll or the invoicing job. Thus the three jobs are processed intermittantly in a kind of perpetual ' interruption cha-cha '. If of course all three jobs were waiting for data no use could be made of the central computer—the arithmetic unit, the mill, the fast store—and they would be ' idle '. It can be seen, though, that if this type of processing is possible it could use the computer very fully and thus give real savings to management.

Parallel Spending

A system of priorities is essential so that the control unit knows which jobs to go to next, and the computer must be able to remember where it has reached in each program. Machines like Orion, KDP 10, ICT 1301, AEI 1010 and Leo III, can do processing in this way either by built-in priorities or special programmed priorities. For instance a list of the separate programs to be performed, with the links to the next instruction in each, can be kept in a special part of the store in the order of priority in which they should be obeyed. At any interruption of one program, control will jump to this list and test each program in turn to see if it is possible to proceed with it—*eg.* if the data transfer which had been originated previously was yet finished. The program lowest in the list will of course have the least opportunity of being obeyed since it will be performed only when all the others are waiting.

The order of priority may be determined by the importance of the program to the user or by the fact that the program uses some piece of equipment which must not be kept waiting—like a Xeronic printer.

But are there any snags? There may not of course be enough time to share—*ie.* the hesitations for all the input/output units that are operating might occur so frequently that there is no time left for the processing of the current program. This will depend on the speed of the internal machine, the speed of the peripheral units, and the number of units in operation.

There is also a cost snag to consider—the cost of the considerable number of peripheral units required to run these three jobs at once. For instance in the example given the requirements might be

(a) payroll—two tape units, two card readers and a printer,
(b) invoicing—three tape units, a card reader, a card punch and a printer,
(c) sorting—four tape units.

This would mean a total of nine tape units, three card readers, two line printers and one card punch, and probably several tape control units to operate several tapes at once, with a large fast store to hold the programs and data. This is an immense amount of equipment and though it may mean parallel programming it also means parallel spending. It is possible that the three jobs could be performed much cheaper with less auxiliary equipment and still within the time available to the user, by processing one or two jobs at once. We should beware of the intellectual attractions of running several jobs at once until we have fully costed it. The right blend of applications would probably be a commercial one and scientific one; the former requiring much input/output operations and relatively little computing, and the latter using the central computer intensely but little input/output. But management will probably find it difficult to realise this ideal of running two such tasks at once.

Nothing New?

Dr Booth (1) has stated that ' there has been much talk lately about " time-sharing ", a supposedly new idea for computers in which they will interrogate various priority jobs. In fact this has been envisaged for many years and involves nothing new. No special instructions are really needed since all existing computers can be programmed to do just this by the use of branch instructions and the normal input or inputs: ' He is correct in stating that it is not a new idea but the ' interruption cha-cha ' is certainly helped in practice by the built-in features of the newer machines. Indicators showing the programmer that a certain operation is finished, or the automatic break-in without the need for any programmer action, make the time-sharing easier and quicker. On the older, slower machines it took so long by program to do these things and store the link, that there was not enough time left to make it worthwhile to share.

The ICT 1301 represents an interesting method of time-sharing on card input and output, and printer output, which does not require hesitation features in the hardware but makes use of the programmer's skill. This probably means that the hardware does not cost so much, and the method is possibly more akin to the type to which Dr Booth was referring. The magnetic tape hesitation system however is automatic and built-in to the hardware, similar to the method used in Orion. But card and printer devices are far slower than magnetic tape units and allow time between units of data for action by the programmer so that built-in facilities are not so necessary.

The 1301 allows time to be shared between card reading and any other

programs by giving signals (setting indicators) at various points in the card cycle which the programmer can test and then take appropriate action.

The card reader operates at 600 cards a minute giving a single card cycle of 100 milliseconds. Only 57 milliseconds of this cycle are concerned with the actual photo-electric reading of the 80 columns of the card; the remaining 43 milliseconds are concerned with moving the card from hopper to stacker. This 43 milliseconds, therefore, can be spent performing other operations such as calculating and printing, as long as the program returns to the card reader in time to gather the information from the next card read by the photo-electric cells. Moreover of the 57 milliseconds only a small portion of the time is actually spent on dealing with the card columns and the rest is available for other operations such as calculating or printing. The data from the card are presented to a special register—Register C—three columns at a time. The programmer must ensure that he returns to extract information from Register C and check it, before it is over-written by the next three columns. Three columns are read into Register C every 2.07 milliseconds and must be cleared from the register within about 550 microseconds. So the programmer must plan to leave what other operations are being performed and jump back to the card program every two milliseconds. Note that there is no automatic break-in of the other program but instead the programmer arranges to test a special indicator set by the entry of the next three columns into Register B, to see if it is necessary yet to jump to the card program. He must also remember where he was in the interrupted program *ie.* set the link, so that he can return to that program. To make sure the indicator is not missed the testing is performed approximately every 500 microseconds, and a control routine jumps like a grass-hopper from one program to another.

In older machines, of course, there would hardly be time to obey one or two instructions in the interval between dealing with one set of three columns and the next. But the 1301 is a megacycle machine with an add time of only 21 microseconds and can carry out many operations in the time, and thus perform parallel operations. In fact every time the control routine jumps to the card program it takes about 400 microseconds to extract the three columns, check them and store them, thus leaving on average some 1,600 microsecs for other work before jump-

ing back to the card program. At the first and last columns some extra time is used for the card reader. Thus in addition to the 43 milliseconds about two thirds of the 57 milliseconds are available for other work, so that only about 20 percent of the 100 millisecond card cycle is actually used for the card reading program.

This mode of time-sharing means that the routines must be written in short sections of some 300 to 500 microseconds, to allow the testing of indicators and the jumping from one routine to another. In the 1301 the punch and printer also operate in this programmed time-sharing fashion, which saves hardware but relies on the programmers' skill and knowledge of exact timing.

ICT are providing users with standard routines for the operation of these input/output units. These routines are known as PPF's—Print, Punch, Feeds—since the printer, the punch and the card reader all operate together by utilising the spare time between 'chunks' of action on each unit. The separate programs are governed by a control routine which jumps from one program to another by means of testing indicators to determine where action is next required. This is definitely parallel programming but as Dr S Gill (2) has stated, 'strictly speaking the control unit does not obey the two different parts of the program simultaneously, but if it switches frequently from one part to another the overall effect is very similar to having the two parts executed simultaneously.'

Programming more complex?

Is programming made more complex by time-sharing, and if so does it take longer and cost more to put an application on to a computer?

If all programs had to be written in very small sections of only a few hundred microseconds each, in order to link in with sections of other programs, the task would not be impossible but it would involve very detailed considerations of timing. It would also restrict the ability of a programmer to write his programs without worrying about with which routines they would be 'time shared'. But on the whole it seems that in the future parallel processing will have the facility to be automatically interrupted, to remember automatically the return link, and to jump to a routine of higher priority without the need for any programmer action. In this respect programming should not take longer or be more costly. But there are other problems which raise difficulties.

For instance the question of allocation of storage can be tricky. If two programs attempt to run on the machine at the same time, it may be found that there is not enough internal memory to store both programs at once. The question of which programs should be run together may be decided either by the computer working on a special scheduling routine or left to a human operator. It is essential if several programs are running at once that the storage or the input/output units required by one should not be used by another, and there must be no danger of jumping from a step in program A to a step in program B.

It has been suggested by Mr C Strachey (3) that a master program called the 'Director' could handle these problems. The Director would be kept constantly in the computer and 'arrange that no program can alter the interlocks of any other program, and thus to give protection against programs under test running wild.'

The Dodo Race

Other problems that may arise are the costing of jobs, which are running and interrupting each other, if time is being hired; the complexity facing the operator if several jobs are in operation at once and an error occurs in one; and the desirability of testing a new program while performing a production run on an old program. It reminds one of the race arranged by a Dodo in 'Alice in Wonderland' in which 'they began running when they liked, and left off when they liked, so that it was not easy to know when the race was over.'

However when machines are actually being operated problems of this sort have a way of being solved empirically, and we can look forward to seeing the first installation where they are tried.

The Verdict

Generally, managements can take note of the fact that time-sharing is a very interesting technique which in certain circumstances can increase the productivity of a computer system. But publicity to the effect that it gives 'nine lives to the cat' is very misleading. To perform several different applications at once normally requires a large amount of peripheral equipment and a large fast store, which puts up the cost of an installation. The number of peripheral units that can be operating at once is limited by the time available, or putting it another way, by the speed of the equipment especially the basic computer.

It is said that on Emperor Hadrian's tomb appears the epitaph 'A multitude of Physicians have destroyed me'. Let us hope that the substitution of publicists for physicians will not be the comment in the event of time-sharing being stressed to death.

(1) Dr A D Booth, 'The Future of Automatic Digital Computers', The Computer Bulletin, Vol. 3, Numbers 5-6 March 1960.

(2) Dr S Gill, 'Parallel Programming', The Computer Journal, Vol. 1, No. 1, April 1958.

(3) Mr C Strachey, 'Time-Sharing in Large Fast Computers', Computers and Automation, August 1959.

SOME ADVANTAGES OF TIME-SHARING

- Computers with the time-sharing facility dispense with costly, one-purpose-only buffers
- The most expensive part of the computer—the arithmetic unit—is much more fully utilised
- Also the best use can be made of peripheral equipment
- Less equipment will be required, so jobs cost less to do. Costly offline equipment may be eliminated
- Block lengths can be varied (as they are not limited by the size of buffers), and so the layout of entries can be varied

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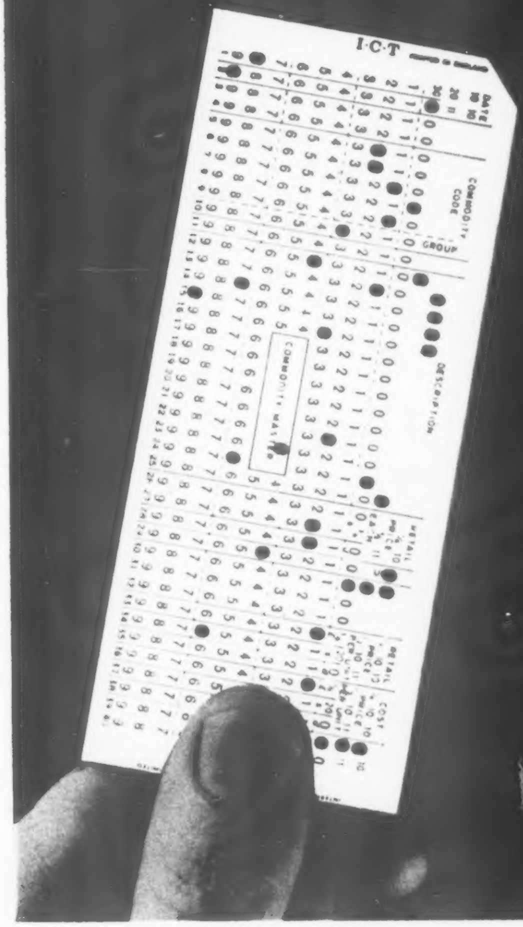

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